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nt MILL EDITION of

ncrete

JANUARY, 1933

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Chicago, Illinois

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E STIMULATING EFFECT OF AN R. F. C. LOAN

RY practical example of the manner in which F. C. loans may be translated into employment ater business activity is supplied by the 00 railroad and vehicular bridge project at New Orleans, on which a loan of $7,000,000 has been made.

◖ It is estimated that this project will provide direct labor totaling 3,510,000 man-hours. In addition, several times this amount of labor will be involved in supplying the material for this structure, which will utilize 62,000 tons of steel, 300,000 barrels of cement, 185,000 cubic yards of gravel, 100,000 cubic yards of sand, and 2,200 cubic yards of granite masonry. The work will also require the use of tugs, lighters, mixers, cranes, pumps, compressors, tools and hoisting cable, representing an outlay of more than a million dollars.

◖ This project will provide a definite stimulant to business in the New Orleans region, on a loan of seven million. Multiply this effect by 200, and you have the potential effect that may be produced if the entire fund of a billion and a half for self-liquidating construction projects is put into action.

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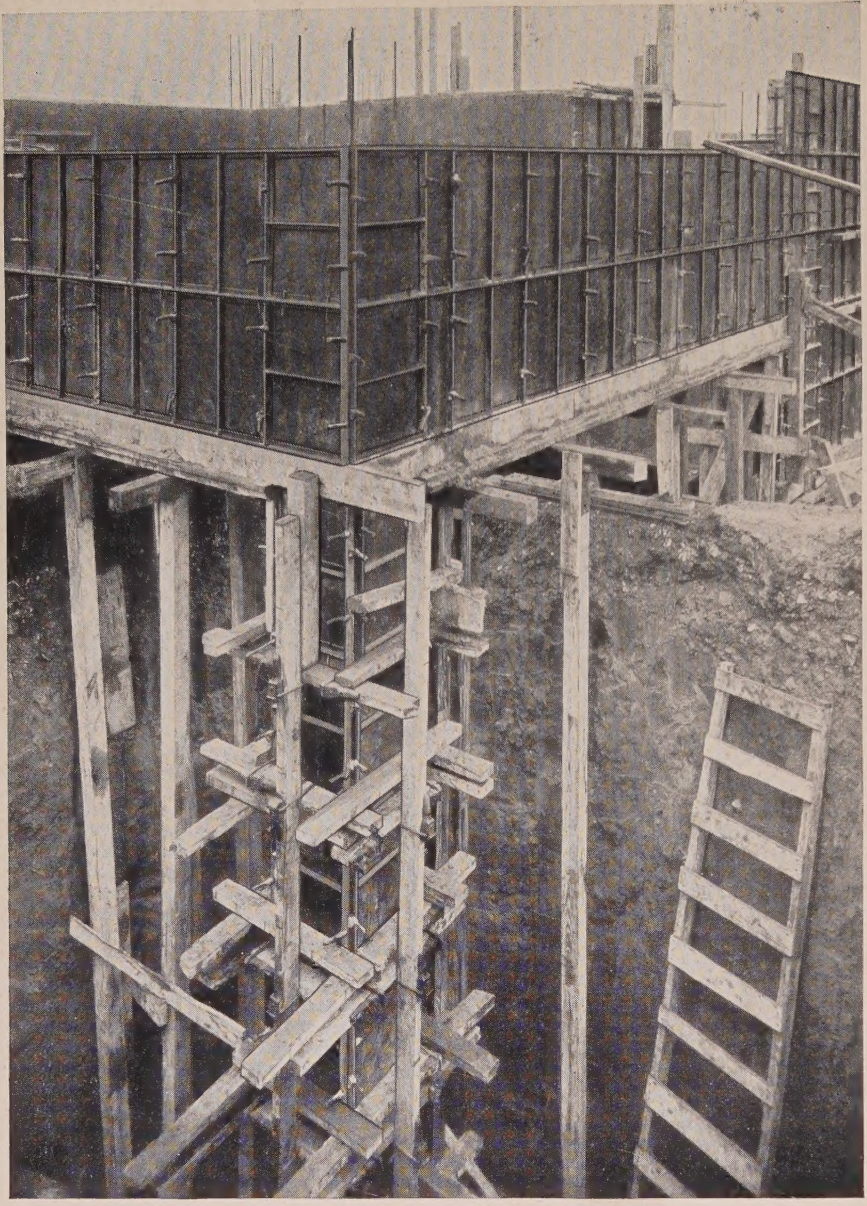
The Adjusted Work-Week



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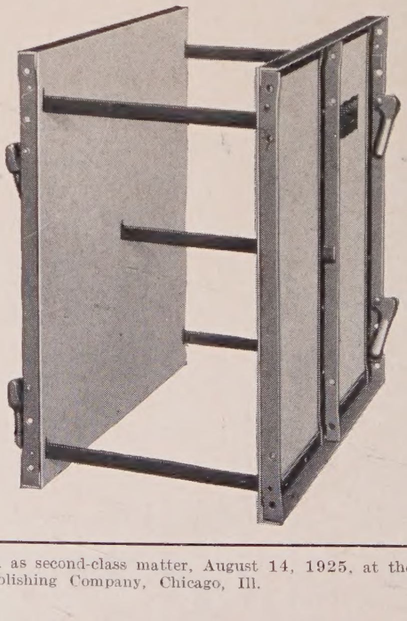

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CONCRETE

Volume 41 January, 1933 Number 1

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Concrete

Volume 41 February, 1933 Number 2

NORMAN M. STINEMAN, *Editor*

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Established 1904

Concrete

Volume 41 March, 1933 Number 3

NORMAN M. STINEMAN, *Editor*

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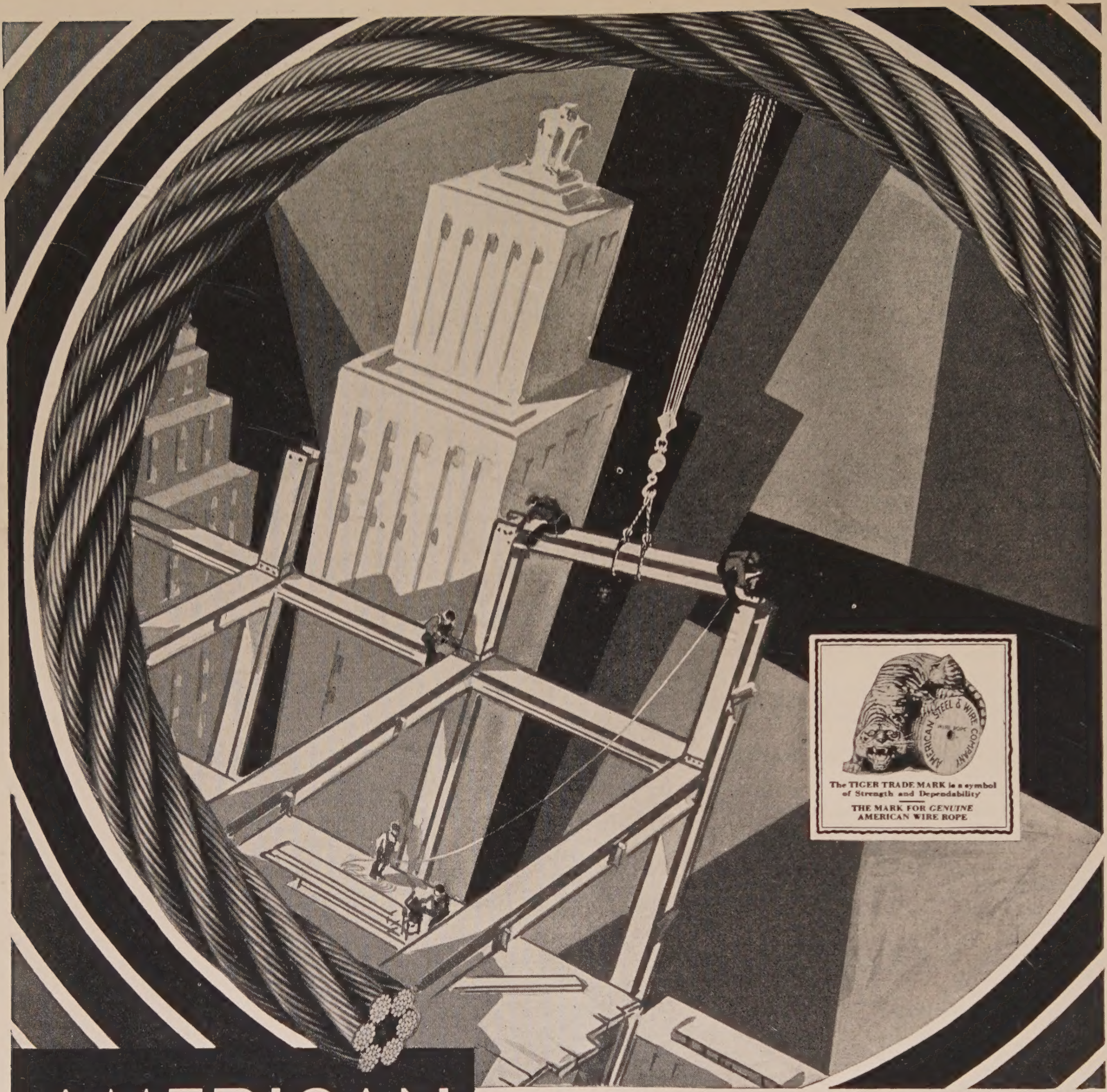
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Concrete

Volume 41 April, 1933 Number 4

NORMAN M. STINEMAN, *Editor*

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SIMPLE *as* 1-2-3

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FIRST: Put two parts of coarse aggregate (1/8″ to 3/8″ size) in your topping mix, with one part portland cement and one part coarse-grain sand.

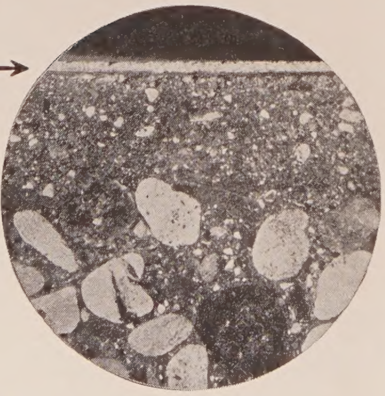
SECOND: Go easy on mixing water—not more than 5 gallons per sack.

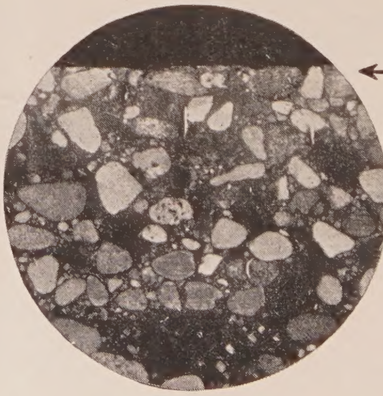
THIRD: Float at once, but don't steel trowel until absolutely necessary (under average conditions, 30 to 40 minutes). Trowel only enough to produce a true, even surface. When hard, cure under wet cover.

That's all there is to it—and the right way usually costs no more than the old-fashioned way. Write the Portland Cement Association if you want more information. It's yours—for the asking.

Wrong

See that white line?——→ It's a "dust on" type of finish, too soft, too porous to stand the gaff of wear. Picture shows a cross-section cut from a slab that crazed in ten days after finishing.





Right

←——See the coarse material in the surface of this section? This is the kind of concrete floor that gives lasting satisfaction. Yet it is simple to lay and ordinarily costs no more than the old-fashioned method.

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Volume 41 May, 1933 Number 5

NORMAN M. STINEMAN, *Editor*

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Cement Bound Macadam

CEMENT BOUND MACADAM —FOR SECONDARY ROADS

SIMPLE TO BUILD—EASY TO MAINTAIN

Cement Bound Macadam is a tough and durable surfacing for secondary roads—where low cost is one of the "musts." It is a new application of an old, well-tried method—used in the United States since 1906.

Wherever good crushed aggregate is available—clean, hard, and tough; larger than the 1½-inch size—this method produces a road low in cost, simple to build, easy to maintain.

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Volume 41   June, 1933   Number 6

NORMAN M. STINEMAN, *Editor*

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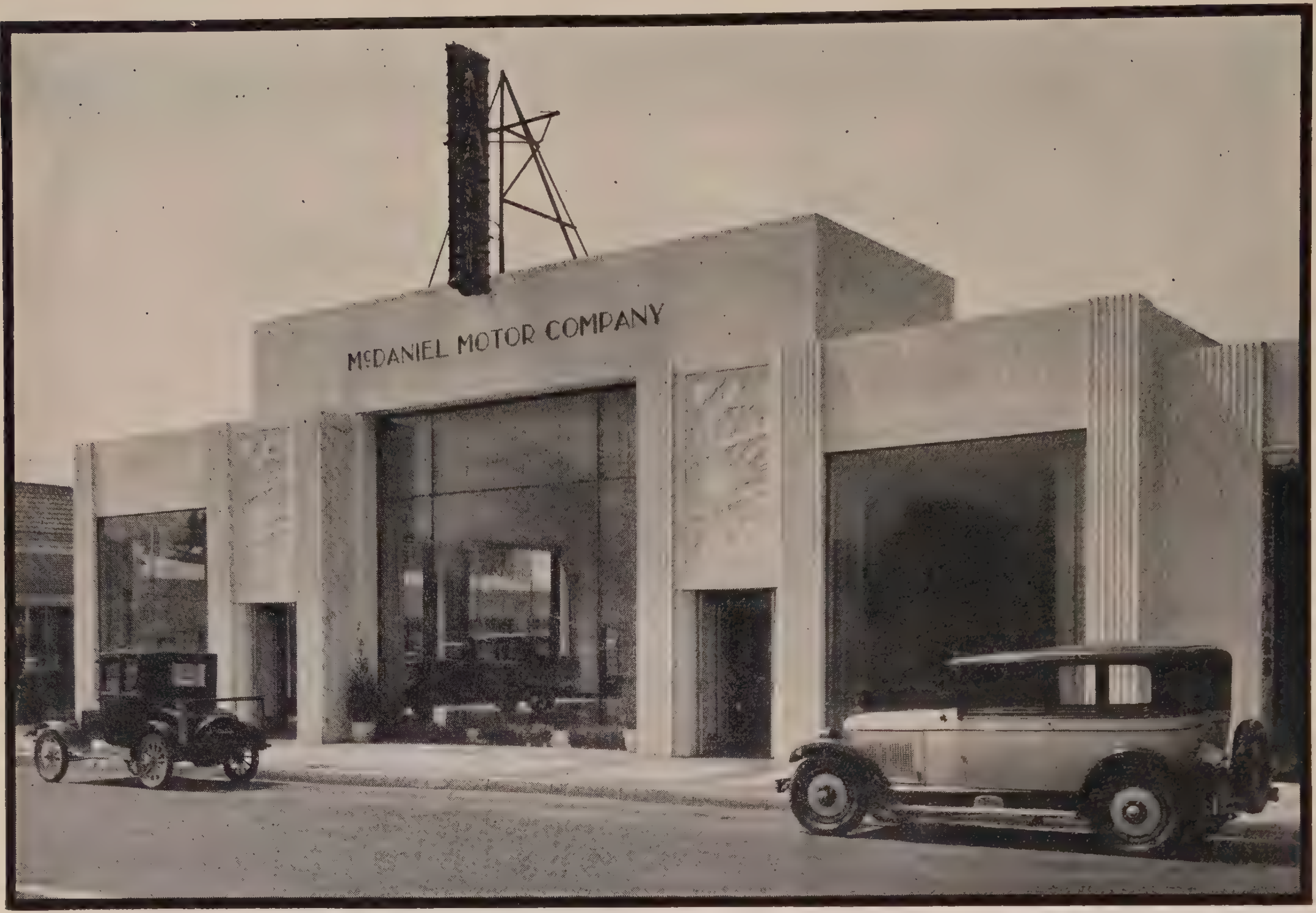
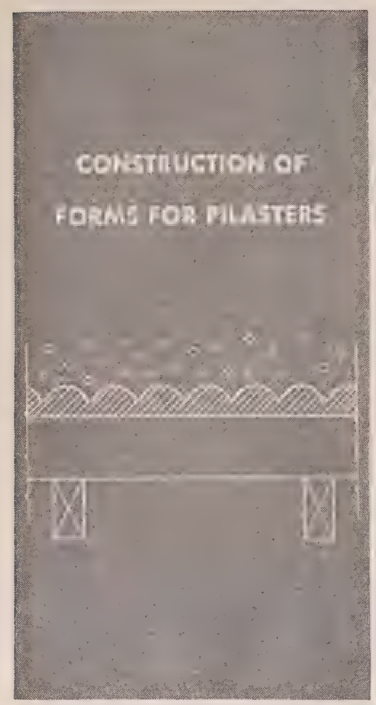
MONOLITHS IN CONCRETE





Concrete Sets a Magnificent Stage for Greater Sales

Decorative features of this building are architectural concrete, cast in place. Panels above the doors were cast from plaster waste molds built into the forms. Flutings in the pilasters were cast in wooden forms constructed as shown in the accompanying sketch. Plain wall surfaces were produced by rubbing in a cement wash with a carborundum brick.

Widely varying color effects can be obtained in monolithic concrete through the use of tinted cement paints.

Monolithic concrete is an ideal material for stores and other commercial buildings where appearance plays an important part in attracting customers. Write us for further information.

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Concrete

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NORMAN M. STINEMAN, *Editor*

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he hides behind the *"cheap road"* budget

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NORMAN M. STINEMAN, *Editor*

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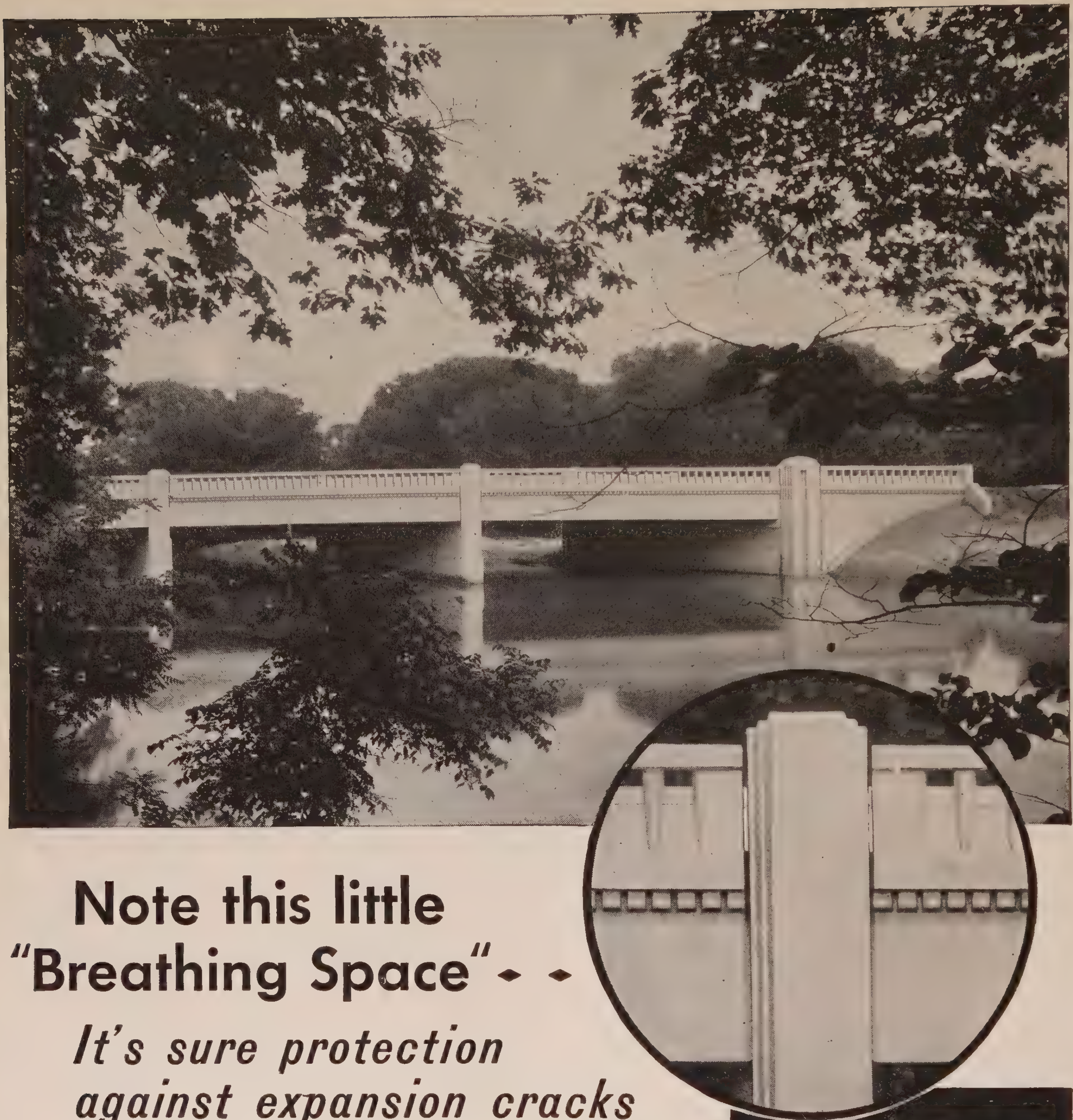

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Volume 41 September, 1933 Number 9

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STOP HIM

from grabbing his sly toll on *Your* roads

● The taxpayer who drives for a mile on a dirt road pays unseen tribute of 2c to "HI" DRIVING COST—Driving the same distance on gravel—the tribute is 1¼c. For dirt and gravel roads cost, on the average, that much more to *use* than does smooth, long-lasting concrete.

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PUNISHING TRAFFIC

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For the Floors You Top This Modern Way

Resistance to wear depends on the way you top a concrete floor. Plenty of coarse aggregate at the surface makes a floor that won't scale . . . won't dust . . . even after years of pounding by heavy traffic.

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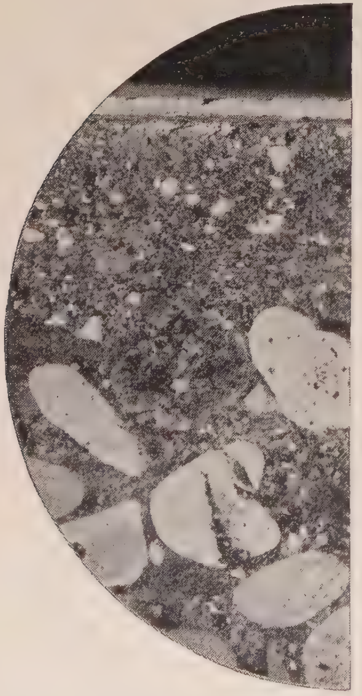
See that white line? It's a "dust on" type of finish, too soft, too porous to stand the gaff of wear. Picture shows a cross-section cut from a slab that crazed in ten days after finishing.



Top your floors this simple, modern way:

1. Two parts coarse aggregate (1/8 to 3/8 in. grade) to one part cement and one part coarse-grain sand for your topping mix.
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RIGHT

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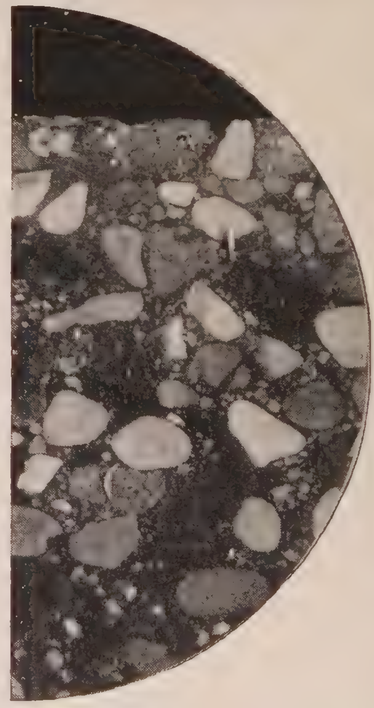

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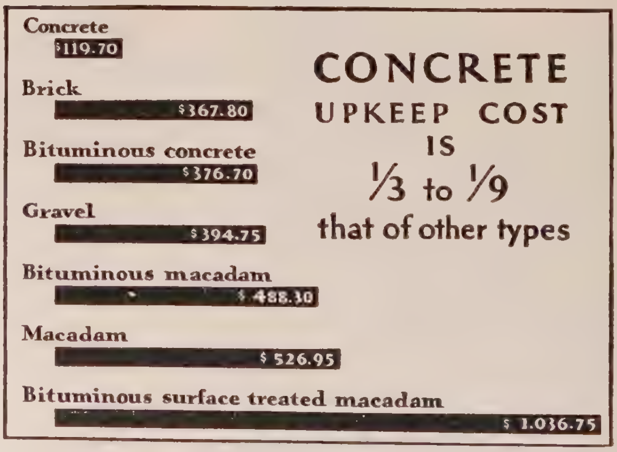

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Concrete

Volume 41 December, 1933 Number 12

NORMAN M. STINEMAN, *Editor*
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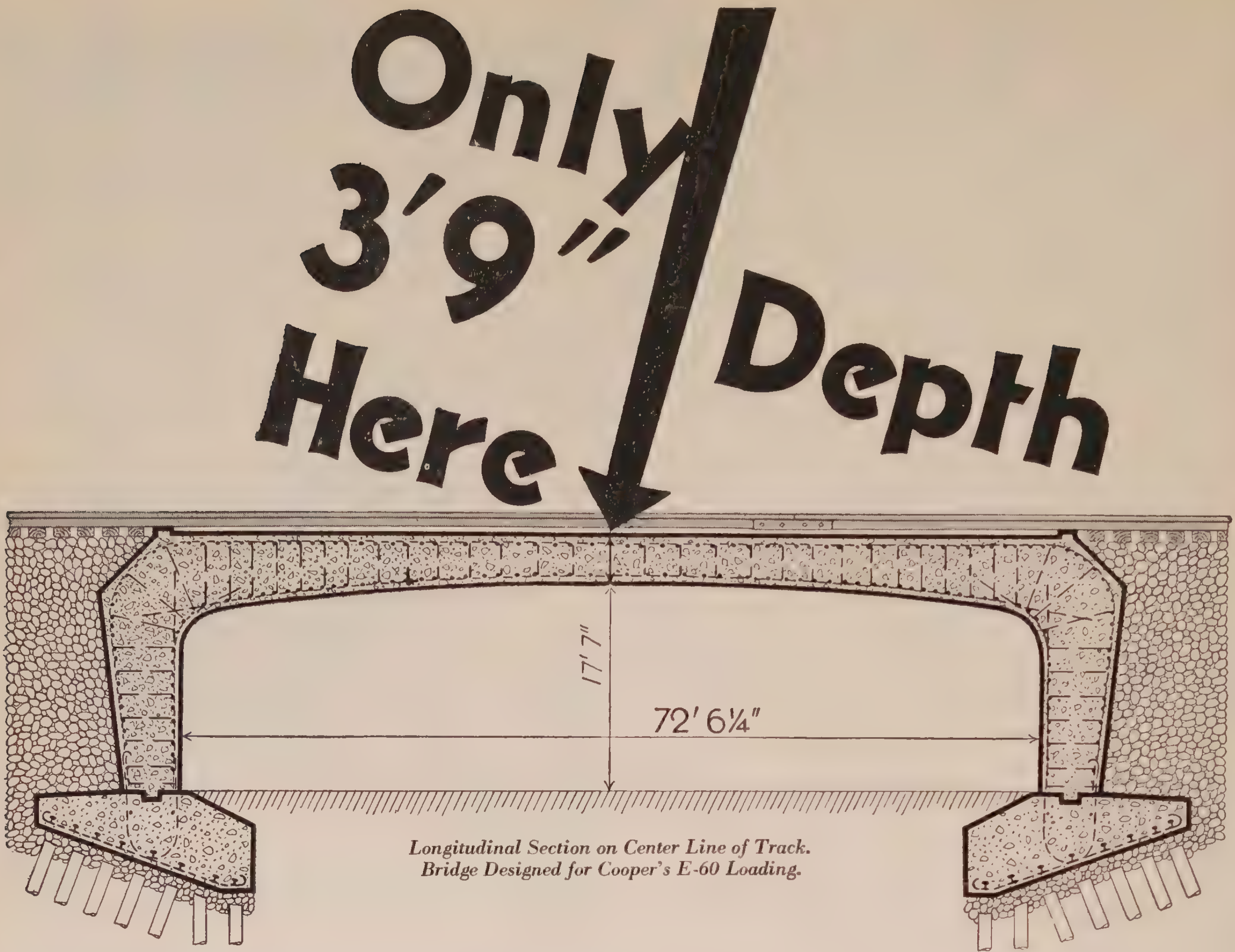

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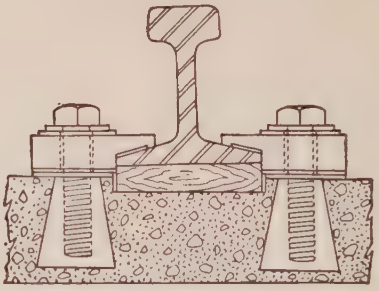

The bridge shown above in simple diagrammatic section is now under construction by the Canadian National Railways near Vaudreuil, Quebec. It is a double-track bridge on a skew crossing and on a curve. Built half-at-a-time, maintaining traffic on one track. No ballast or ties are used. Instead, the rails are fastened to the concrete deck with a cushion block of oak beneath the rails.

PORTLAND CEMENT ASSOCIATION

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Vol. XLI, No. 1 CONCRETE January, 1933

Advanced Ideas Find Encouragement in Concrete Road Construction

Year's Addition of 8,240 Miles Considered Favorable—Increased Interest in Secondary Road Construction—Many Experimental Studies Under Way

WHILE contracts awarded for concrete road construction in 1932 fell below the yardage awarded in each of the previous two years, the totals for the year just closed have reached a gratifying figure—a much better figure than seemed possible earlier in the year.

8,240 Miles of Concrete Road

The manner in which highway departments have pushed concrete road construction during the later months of the year is well illustrated in the chart published elsewhere in this issue. The success of this effort, made possible, in part, because of the fund of 120 million dollars provided in the Federal Relief Act, accounts for the unexpected showing for 1932. With nearly 82 million square yards awarded in the first eleven months of 1932, it is expected that the final figure for the year will be around 87 million, comparing with nearly 112 million in 1931 and 108 million in 1930. The 1932 yardage is, in consequence, equivalent to 8,240 miles of 18-ft. concrete road.

Widening and Resurfacing

States and counties that have their road construction programs well advanced have continued in their work toward relieving traffic congestion in metropolitan areas. Widening of existing roads, often accompanied by resurfacing of the old slab with a 5-in. or 6-in. thickness of reinforced concrete, is one of the methods frequently employed. State highway practice for both widening and resurfacing were discussed, and illustrated with standard cross-sections, in the March (1932) issue of CONCRETE, pages 17-18. The use of concrete in resurfacing old city street pavements was described in the January issue, pages 15-16.

Relieving Metropolitan Congestion

In connection with the relief of traffic in metropolitan areas, one of the greatest undertakings ever attempted in this direction was completed late in 1932, when the Jersey City-Newark overhead highway was opened to traffic early in December. This 4-lane structure, about 3 miles in length and costing about $18,000,000, stands as convincing proof that highway construction is continuing in spite of reduced income, diversion of funds, and other obstacles.

The fact that many states and counties are approaching completion of their primary highway systems has resulted in directing attention to secondary roads. Here the opinion of highway engineers has been divided, one group favoring cheaper types of pavement for secondary roads, the other favoring more permanent road types such as single-lane concrete because in the long run the longer service and lower maintenance cost of this type makes it the most economical over a period of years.

The presentation of the case in favor of single-lane concrete for secondary roads will be found in two detailed and well-illustrated articles by E. M. Fleming, in the April and July issues of CONCRETE.

An additional factor in secondary road construction appeared during the year through the revived interest in cement-bound macadam. Some six or eight state highway departments constructed experimental sections of this type, ranging in length from a few hundred yards to 1⅓ miles, during the year. Much credit for the renewed interest in this type is due the Portland Cement Association. An interesting article describing one of the approved methods of construction in cement-bound macadam, written by U. J. Eckman, appears in the November issue of CONCRETE, while a more detailed article appears in this issue.

Use and Handling of Bulk Cement

The practice followed by a number of state highway departments in the use and handling of bulk cement is discussed in considerable detail in an article in the June issue of CONCRETE, pages 23-24; but perhaps the most interesting development in this direction was the appearance, during the year, of two types of self-unloading railway cars designed especially for the shipment of cement in bulk.

One of the types of railway cars just mentioned is the tank car developed by the General American Tank Car Corp., which unloads the cement with its own mechanism. Another is a covered hopper car, designed to unload by gravity, which has been put in service by several railways. Further information concerning this new railway shipping equipment will be found in CONCRETE in the issues of October, page 18, and November, page 24. There is little question that the development of this new railway equipment will result in the greater use of bulk cement in highway construction work.

Density and Workability

Developments looking toward continued improvement in the quality of concrete for highway pavements have been going steadily forward. There is evident a constantly growing appreciation of the fact that density is perhaps the most important factor in attaining durability, and that workability is probably the most important single factor in the attainment of density. In the meantime the strength of the concrete and the soundness of the aggregate are not being overlooked.

Two Sizes of Coarse Aggregate

The employment of two sizes of coarse aggregate has been found to be another important factor in the quality of concrete for paving work. Elimination of segregation, greater density, improved workability, increased strength, and greater uniformity from batch to batch are some of the advantages mentioned by state highway engineers in a survey published in the May issue of CONCRETE, pages 11-12. That survey disclosed the fact that 17 states now specify the use of two or more sizes of coarse aggregate in concrete highway work, while seven or eight others have had experience with this method of proportioning.

The use of separate sizes of coarse aggregate is also advocated and discussed in the October issue, pages 17-18, by G. W. Hutchinson.

Large-Scale Investigations

Investigations of various phases of concrete highway construction have been carried forward by a number of state highway departments. Notable among these are the following:

Cement Factor. A survey of highway practice with respect to the cement content per cubic yard of concrete, printed in the April issue of CONCRETE, pages 9-11, disclosed a wide variation on this point. A most ambitious program of investigation of the subject has been under way in Texas, by the state highway department.

Curing with Kraft Paper. The Iowa highway department has taken the lead in the development of practice in the curing of concrete pavements through the use of heavy kraft paper. The highly successful experiments conducted by the department were described in an article by Mark Morris, in the June issue of CONCRETE, page 29.

Use of Calcium Chloride. In an article by H. F. Clemmer, on pages 9-11 of the November issue of CONCRETE, the author discussed, in detail, what he describes as the logical use of calcium chloride in concrete for pavements. The investigation reported by Mr. Clemmer included studies of this material as an accelerator, as a means of overcoming the effect of low temperatures during setting, as a means of attaining high early strength, and so on.

Hot Cement. Because of the practice, in some cases, of delivering cement for state highway work direct from the cement mills, highway engineers often encounter the problem of what to do when such cement still retains the heat produced in its manufacture. This question was thoroughly investigated by a committee representing the American Society for Testing Materials. As reported on pages 11-12 of the November issue of CONCRETE, the committee found that hot cement is only a minor factor in the final temperature of the mixed concrete, and that its effect is in no way detrimental.

Experimenting with Cement-Bound Macadam. Reference has already been made to the fact that some six or eight states have built experimental stretches of cement-bound macadam during 1932. This question is discussed in detail in an article in this issue, and in the November issue, page 8.

Highway Maintenance Costs

The low maintenance cost on concrete roads and streets was emphasized recently in an article by Arthur L. Boley, on page 12 of the December issue of CONCRETE, in which maintenance costs in Sheboygan, Wis., are given for a period of 22 years. During this period the maintenance costs averaged about one-seventh of one cent per square yard per year.

Other records of maintenance costs are mentioned in a short article on page 23 of the same issue.

An interesting development during the year is the use of carbon black for coloring concrete roads. The quantities required, the effect on strength and workability, and other pertinent data, are discussed in an illustrated article by Miles N. Clair, on pages 20-21 of the November issue of CONCRETE.

Railway Uses of Highways

The possibility that railways, through the use of motor-truck transportation as feeders, may become extensive users of highways is no longer a matter of mere theory. Leaders in the railway industry have discussed the possibilities in such a development in more serious fashion than ever before. The need of preparing for a large expansion of motor-truck traffic, as a result, was discussed editorially in the May and October issues of CONCRETE. In the later editorial, mention was made of the actual introduction of such a service between Chicago, Milwaukee and South Bend, by several railroads acting through the Railway Express Agency. While presumably this service was inaugurated as an experiment, it proves that railroads are giving serious consideration to the problem, and that highway engineers must take the possibilities into account.

Possibilities of 1933 Theme of Masonry Meeting

Believing that opportunity is in the offing for the products manufacturer in many lines, the program committee of the Concrete Masonry Association is working to build its main session around the theme of "Opportunity Ahead."

In outline, the session will cover such subjects as precast floor construction, the development of ashlar for both interior and exterior, the opportunity ahead in the small fireproof home field, opportunities for securing more of the federal building program, co-operation between manufacturers in putting across successful advertising, as well as a brief review and forecast.

The association is holding a one-day program on February 23 at the Palmer House, Chicago, Ill., adjourning that evening to the American Concrete Institute sessions.

Build Cement-Bound Macadam Type for Secondary Roads

Construction of Five Experimental Sections of Macadam Grouted with Cement Mortar Indicate Its Feasibility for Low-Cost Roads

CONSTRUCTION of five experimental sections of cement-bound macadam pavement in New Jersey, Pennsylvania and New York at a cost of approximately $1.00 per sq. yd. has convinced highway officials that this type of construction is well suited for surfacing those highways commonly known as secondary roads.

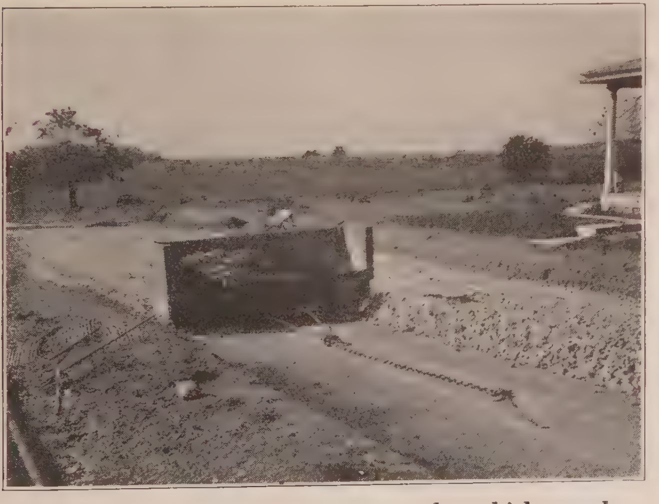
Cement-Bound Macadam Not New

The cement-bound macadam pavement is not new. Street and highway surfaces of this type can be found in nearly all parts of the country. Such pavements were promoted and constructed from 1906 to 1920. A street in Lynn, Massachusetts, paved with cement-bound macadam 26 years ago is still in good condition and has required practically no maintenance. Several stretches of this type of pavement on the Boston Post Road are now 18 or more years old and are successfully carrying the enormous traffic of this famous highway.

With these and many other examples of cement-bound macadam to guide them engineers are convinced that this type of pavement is durable. The recently-constructed experimental sections were built to determine how modern machinery can be applied to this old-time pavement to produce a sturdy, low-maintenance surface for the lighter traffic highways at a minimum of cost.

Build Experimental Sections

The first experimental section was constructed in Morris County, New Jersey, on the Meyersville-Chatham Road near the village of Myersville. County officials were so pleased with this 500-ft. section that they immediately built another 500-ft. section on the same road near Chatham. Both roads were built with county maintenance forces and with equipment already belonging to the county.



An efficient home-made stone spreader which can be set to give any desired thickness of loose stone. The long chain is fastened to the front bumper, which makes a speedy hitch with a downward pull

The next experimental section was built by the Pennsylvania Highway Department on the Bath-Moorestown Road. It is a mile long and, like the other sections, 18 ft. wide and 6 in. thick. About the same time a short section was built in Somerset County, New Jersey, near North Plainfield.

The completed cement-bound macadam pavement is as smooth-riding as any macadam surface, is durable, and maintenance charges are low. Cost of five experimental sections constructed in eastern states was approximately $1.00 per sq. yd.

The Pennsylvania job was built by the State Highway Maintenance Department, using its regular maintenance forces and equipment. The Somerset County job was built by county maintenance forces.

To determine how such work would be handled by contractors, the state of New York let a contract for one mile of cement-bound macadam which has just been completed. It is in Orange County, on the Newburgh-Vails Gate Road.

About the same construction methods and equipment were used on all of the jobs, the principal difference being the type and size of stone.

Construction Methods

The subgrade was brought to its final elevation by a blade grader. On four of the jobs no forms were used, so the pavement edge of the shoulder was made as nearly vertical as possible.

Stone was either spread by end dumping from a truck, as on the shorter jobs, or with some type of stone spreader box. The spreader box proved much superior to the rather hit-and-miss end dumping, and a home-made type of box proved very efficient. Stone was spread to a depth of 7½ in. so that, after compaction, it would have a depth of 6 in. Following the spreading the stone was rolled with a 10-ton, 3-wheel roller.

The cement grout was proportioned 1 sack of cement to 2 cu. ft. of sand and an average of 7½ gallons of water. It was proportioned at a central plant and hauled to the job in truck mixers.

Truck mixers were equipped with discharge chutes. When a chute was used alone, the velocity of the grout was sufficient to disturb the rolled stone, frequently washing shallow pockets in it. A distributor was therefore devised for the end of the chute, consisting essentially of baffles in a box having holes in the bottom. The holes directed the flow of the grout vertically downward. Even then the stones were sometimes disturbed, so on the last job long strips of burlap were attached to the distributor in such a way that they dragged over the stone beneath the distributor and the grout fell upon them before striking the stone. This entirely eliminated the disturbance of the stone by the grout.

After grouting, the pavement was rolled to further smooth up the surface and also to aid in the penetration of grout. A tandem roller was found far superior to the 3-wheel type for this latter rolling.

The rolled, grouted surface was checked with a straightedge, and inequalities were corrected either by removing or adding stone. Finer stone was provided for filling up shallow depressions. Small bumps were sometimes reduced by hand tamping. After the final rolling, the grout was distributed by brooms or hand floats and the surface finish was given by two burlap belts, the first being drawn forward with a sawing motion while the second was pulled forward without any sawing.

The Pennsylvania job was cured with burlap that was kept wet for 48 hours. On the New York job 2 lb. of calcium chloride per sack of cement was mixed with the grout as a means of curing. Much of the New York job was built at temperatures only a little above freezing. The calcium chloride hastened the hardening of the mortar sufficiently to allow final rolling and finishing of the pavement much sooner than had been possible on any of the other jobs, though these other jobs were built in warmer weather. For cool weather construction, at least, this admixture of calcium chloride was very desirable.

Size and Kind of Stone

The size and kind of stone varied somewhat on the different jobs. On one a limestone was used having an average wear of 4 per cent in the standard test for abrasion. It ranged from 1¼ to 2¾ in. in size, with a tolerance of 15 per cent passing the 1¼ screen. It was found that rolling operations and the wheels of grout trucks abraded this stone considerably, and that this dust, combined with the material passing the 1¼ screen, settled to the bottom, where it filled the voids in the stone and prevented penetration of the grout. On other jobs a good grade of trap rock, in some cases 1¼ to 2¼ in. in size, and in one case from 2½ in. up to crusher tailings, was not appreciably worn off by rolling or truck traffic, leaving the voids free for the complete penetration of grout.

It is concluded that the stone for cement-bound macadam must be hard and tough and be entirely free from the finer sizes. When very hard stone is not economically available, construction should be prosecuted in such a way that a minimum of rolling and of traffic is placed upon the stone before it is grouted.

On all the jobs the riding surface secured was at least as good as that of other macadam surfaces. The assurance that this surface will remain throughout the life of the pavement is one great advantage of this type of construction over that of the more common macadam types.

Cost Averages $1.03

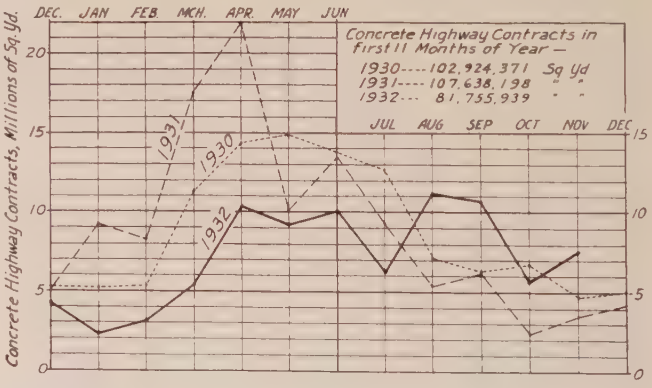
The cost of pavement on all the jobs averaged $1.03 per sq. yd. The mile of pavement in Pennsylvania cost 94½ cents per sq. yd., while the New York job cost $1.08. As more efficient construction methods are developed it is expected that even this low cost will be appreciably reduced.

One of the chief economies of cement-bound macadam is the small amount of equipment required. Two stone-spreading boxes which may be home-made, 2 rollers (or only one for very short stretches of pavement), a blade grader for subgrade preparation, picks, shovels and brooms are all that is required. In areas where secondary roads require pavement it is usually possible to purchase grout from firms having fleets of truck mixers, or to rent truck mixers, and load them at a portable plant near the job.

Concrete Road Awards Move Up in November

Contracts awarded for concrete roads in the United States during the month of November reached the highly encouraging total of 7,591,606 sq. yd., according to figures compiled by the Portland Cement Association.

The November awards are more than twice the total of 3,558,911 sq. yd. awarded in the corresponding month of 1931, and well above the 4,790,288 sq. yd. let in November, 1930. The total for the first 11 months now stands at 76 per cent of the contracts awarded in the same period of 1931.



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The diagram shows the commendable manner in which highway departments have pushed concrete road contracts to levels above normal in the last 4 or 5 months, as a result of which the total for 1932 will make a much better showing than was generally expected earlier in the year.

The Changing Highway World

By E. M. FLEMING
Manager, Highways and Municipal Bureau, Portland Cement Association, Chicago, Ill.

IT is said that man undergoes epochal changes in his physical and mental makeup in 7-year cycles. It might also be said that our modern highway world undergoes similar cyclical changes, but in 10-year periods. In 1902, the automobile began to make itself felt as a revolutionary factor in highway engineering. About 1912 the most far-sighted of our highway authorities were beginning to turn to the concrete pavement as the one best fitted to serve this new form of traffic. 1922 saw the opening of a decade of road building unequalled in all history. In 1932 we are witnessing what appear to be radical and revolutionary changes in our thinking on highway administration and finance.

Where these changes may eventually lead us remains to be seen. A great deal depends upon the ability of those who are familiar with our highway problems to impress their thinking upon the layman and the law maker during the coming sessions of state legislatures.

Program Becoming Sidetracked

During the decade from 1922 to 1931, inclusive, funds available for rural highway construction have grown by leaps and bounds. In 1922 only $898,000,000 was available. In 1931 nearly $2,000,000,000 was spent on these rural highways. In this period our state highway system grew from 250,000 miles to 350,000 miles. At the same time approximately 500,000 miles of secondary roads had been improved in some manner. In short, during this decade we pushed our highway program far on the road to a logical conclusion, one which would have provided a system of paved state highways entirely adequate for the 75 per cent of our rural traffic which uses them, and one which would shortly have released additional funds for the further improvement of those 500,000 miles of secondary roads.

The present period of economic stress is responsible for those actions which are tending to sidetrack us from the only line of attack which promises a real solution to our problems. This period of hard times is responsible for three upsetting tendencies which have been making rapid headway. They are:

1. *Diversion* of highway funds.
2. *Diffusion* of highway funds.
3. *Reduction* of highway funds.

Diversion may be defined as the use of funds collected from the motorist for purposes other than road construction.

Diffusion can be defined as any action which makes the motorists' road building funds responsible for the improvement and maintenance of those rural roads or city streets which are not primarily his burden.

Reduction is just what its name implies. It is the effort to reduce gasoline tax rates and license fees to low levels, regardless of the individual highway needs of the various states.

Diversion has been slowly gaining momentum during the past decade. It is only during this year just closed, however, that it has assumed menacing proportions. In 1930, diversion totalled only $15,000,000; in 1931, it rose to $20,000,000; but in 1932 it reached the staggering total of $125,000,000. If the federal tax on gasoline and motor oils is added to this, then the grand total is nearly one quarter billion dollars. This is about one-fifth of the tolls which have been willingly assumed by the motorist as a means of getting roads over which his car might run.

Highway funds from the motorist have been diverted to schools, to general state purposes, to the federal government, but most of all to the relief of the unemployed. None of these can reasonably be said to be an obligation of the man who owns a motor car. It is only because the highway funds bulk large in these days of depleted treasuries and because these taxes are relatively painless in collection, that the politician and the left-handed philanthropist dare to delve into them so deeply. Even the most willing taxpayer of all, the motorist, can be driven too far, and if the present tendency is continued, there is no doubt that we will succeed in killing this goose which lays such large golden eggs.

Diffusion Appears as a Factor

Diffusion is relatively new. It was begun by North Carolina in 1930, when all property taxation for road purposes was abolished and the state was made responsible for the maintenance and construction of every mile of rural road in the state. Gasoline taxes were increased to provide extra funds, so that the motorist taxpayer now carries the whole load. North Carolina had been progressing nicely in the improvement of its 10,000-mile system of state highways, but with another 45,000 miles added and only $6,000,000 of additional funds, it can be readily appreciated that highway improvement must be spread thin hereafter.

Pennsylvania, Virginia, Michigan and Indiana have followed after North Carolina in equal or less degree. On the face of it the policies adopted in North Carolina may not seem to be a serious hindrance to highway development, but as will be shown later, it is in the same category as putting the cart before the horse.

The motorist contributes to road building through license fees and gas taxes. While license fees per vehicle have increased relatively little during the past 10 years, the number of vehicles and consequently the gross receipts have grown enormously. Receipts from gasoline taxes have grown not only because of an increase in the rate charged, but also because of the increase in the number of vehicles and in the annual mileage traveled by each car. This last increment is due to the expanding facilities for highway travel.

With the addition of the federal tax of 1 cent per gallon early this year the average gasoline tax has become 5 1/3 cents per gallon. As the gasoline tax increased, it opened up opportunities for practices which are unsettling to legitimate business. As a consequence, a relatively strong movement has developed designed to win a radical reduction in the gasoline tax, without regard to the highway requirements of individual states. Not only that, but transportation agencies in competition with the highways have apparently adopted policies which are designed to retard normal highway improvement.

The movements looking toward diversion, diffusion and reduction of highway funds have found a fertile field of propagation because of our present economic stress. Everyone is concerned with the reduction of expenditures. The large funds set up for highway improvement, derived from a class of taxpayers apparently willing to pay, have been, and are, shining marks for those seeking the easy way out. Those who appreciate the value of good highways must individually and collectively set themselves to resist the attacks which will be made on these funds during the sessions of the 41 state legislatures meeting in January, 1933. They must fight to see that these funds are used on highways in a manner which will return the greatest benefit to the motorists who pay these tax bills.

Public Roads in Three Classes

The public roads of the country may be put in three major classes. They are—

1. The primary roads, comprising the federal and state systems.
2. The secondary roads, including the principal county trunk highway or state-aid highways.
3. Third class, or purely local township roads.

To these may be added a fourth class. This comprises those streets within municipalities which are connecting links between the state highways touching the borders of the municipality.

With more than 3,000,000 miles of rural roads in this country, not to mention those relatively expensive arteries in cities which are connecting links in state highway systems, it must be obvious to even the most unthinking that not all of them can be improved at once. If that is so, then what method of attack presents the best means of securing the most good for the greatest number?

Where the Traffic Is Found

Careful traffic surveys have indicated that the 350,000 miles of state highways carry about 75 per cent of our rural traffic. Probably 20 per cent more goes over the secondary roads, leaving about 5 per cent for class three roads. It is clear, then, where it is possible to do the most good for the greatest number, namely, the improvement of state highways first, followed by improvements of connecting arteries in cities.

In 1930 motor vehicle taxes were responsible for 82.1 per cent of the revenues raised for state highways. Federal aid accounted for 10.8 per cent, and property taxes for 7.1 per cent. Of the funds devoted to second and third class roads, 76.5 per cent came from property taxes and 23.5 per cent from motor vehicle taxes. Most of the latter went on secondary roads.

Since the motorist pays nearly 25 per cent of the cost of local road improvement, and since these roads carry, at the most, 25 per cent of the rural road traffic, it seems clear that in general the local roads are receiving a generous share of the motorists' money.

In all fairness, then, and also as a logical method of attack on our highway problem, it seems only right that the bulk of the motorists' taxes should be used to improve highways of general use first. This is the policy which has been followed during the past decade and the one which should continue to be followed until all of the 350,000 miles of state highways have reached an adequate degree of improvement.

Next Logical Improvement

When this has been accomplished, or nearly so, in any one state, the next fair and logical step is the improvement of connecting arteries in municipalities. It cannot be expected that the property owner adjacent to a city artery of general use should pay the full cost or even any considerable part of the cost of an improvement which does not benefit him in any degree and in most cases is a positive detriment. Also, some return must be made within the municipality for those motor taxes which are collected on vehicles which rarely leave the city streets. When these arteries are constructed with state motor funds and under the supervision of the highway department some adequate return will be made to the city motor vehicle owner.

When the highways of general use both without and within the municipality are provided for, it is time to turn attention to the second class of roads. If the general-use highways have been improved with surfaces having low maintenance and upkeep costs, sufficient funds should be available for extensive programs on the secondary roads, particularly if road income is left approximately as it is at present.

It is difficult to foresee the time when motor funds can rightfully be made available for the improvement of third class roads. These roads comprise more than two-thirds of our total mileage and are in large part service roads for the relatively few persons residing on them. They should logically be a charge on local property, not on the motorist.

Summary

In summary, then, we are in acute danger of having our road funds reduced materially through the diversion of these funds to purposes other than road construction and through the outright reduction of gasoline taxes. In addition, powerful forces are at work to diffuse these funds over a much greater mileage of roads than they can adequately care for, thus destroying the possibility of eventually securing a co-ordinated system of improved roads serving the greatest number of motorists. All of these tendencies will reach a head during the next few months. Everyone interested in the orderly construction of a balanced system of highways should make it his duty to fight for the preservation of road funds and for their use to secure the most good for the greatest number.

Schedule of A. S. C. E. Meeting and Convention

The eightieth annual meeting of the American Society of Civil Engineers will be held January 18-21 at New York City.

The annual convention is scheduled for Chicago, from June 26 to July 1.

What Light-Weight Concrete Means in Dollars and Tonnage

Saving in Steel Alone Ranges from 10 to 20 Per Cent—Some Facts Established from Actual Experience—Adding Stories to Existing Buildings

FOR many years the desire for lighter dead weight in superstructures of buildings found expression in the development and use of light-weight building units in partitions, in wall back-up, and for fireproofing purposes. In these fields cinder concrete units have played an ever-increasing part; and monolithic cinder concrete likewise was found useful in the development of lighter floor construction.

Light-Weight Manufactured Aggregates

With the advent of manufactured aggregates capable of producing light-weight concrete of high structural strength and suitable for all purposes, the possibilities for economy were greatly increased. These new materials, producing a high quality of structural concrete weighing around 100 lb. per cu. ft., and still lighter when intended for wall and partition units, made it possible to extend the lighter weight into the great mass of monolithic concrete in structures.

Great Saving in Steel Tonnage

Designers know that this substantial reduction in the weight of monolithic concrete will be accompanied by an appreciable reduction in steel tonnage, whether one is considering the reinforcing steel in a reinforced concrete structure, or the structural steel in buildings that are fireproofed with concrete.

The designer's problem, then, becomes that of balancing the saving in steel tonnage and foundation costs against the greater cost of the light-weight aggregate. Obviously, the net saving increases as the cost of the manufactured aggregate approaches the cost of ordinary aggregates. Yet many designers who have not thoroughly investigated the problem will be surprised at the saving that is possible even when the cost of the light-weight aggregate is considerably higher than the cost of natural aggregates. A few actual instances will illustrate this important fact.

What the Actual Figures Tell

In an article by E. B. White, in the June (1931) issue of CONCRETE, reference is made to the saving resulting from the use of sand-haydite concrete weighing 108 lb. per cu. ft. instead of sand-stone concrete weighing 144 lb. per cu. ft., in the design and construction of the Victor Lawson Memorial Y. M. C. A. Building, in Chicago, in 1930-1931. This building is 104 by 139 ft. in plan for a height of 18 stories, above which there is a 6-story tower of smaller area. The building has a structural steel frame fireproofed with concrete and the floor construction is of reinforced concrete. The floor area is about 280,000 sq. ft. Following is a comparison of the quantities of material involved in the two designs prepared:

(1) The structural steel tonnage was reduced from 2,690 to 2,440, a total saving of 250 tons, or 9.3 per cent.

(2) The tonnage of reinforcing steel was reduced from 650 to 570, a total saving of 80 tons, or 12.3 per cent.

(3) The number of foundation piles was reduced from 1,650 to 1,417, a saving of 233 piles, or 14.1 per cent.

(4) The quantity of concrete was reduced from 6,300 cu. yd. to 6,000 cu. yd., but the cost of the sand-haydite concrete was the greater because of the much greater cost of the light-weight aggregate, which was figured at $5.75 per cu. yd., compared with $1.65 for crushed stone. Had the price of the manufactured aggregate approached more closely the price of crushed stone, the actual saving of $12,580 would have been much greater. The important lesson to be learned from this case, however, is that even with a high price for light-weight aggregate a saving was still possible.

(5) The total saving in dead weight was 7,000,000 lb.

Big Saving on Tall Building

Another case is that of a 47-story building constructed in Chicago in 1928. The building is 100 by 175 ft. in plan to a height of 22 stories, above which an occupied tower extends 25 stories more. The building has a structural steel frame fireproofed with concrete, and floors of reinforced concrete. To obtain a definite basis of comparison, a well known firm of structural engineers prepared two complete sets of plans, one based on the use of ordinary stone or gravel concrete weighing 144 lb. per cu. ft., and the other based on using both fine and coarse haydite as the aggregate, producing concrete weighing 100 lb. per cu. ft. From the comparative designs the following facts were obtained:

(1) The structural steel tonnage was reduced from 7,050 to 6,015, a saving of 1,035 tons, or 14.7 per cent. The saving on this item alone would have been more than enough to pay for the light-weight aggregate at the estimated price of $6.00 per cu. yd.

(2) The quantity of reinforcing steel in the floor slabs was reduced from 1,360 to 1,020 tons, a saving of 25 per cent.

(3) An estimated saving of $25,000 resulted from the smaller required diameter of the cylindrical caisson piers that extend to bedrock about 100 ft. below the street level.

(4) The actual reduction in dead weight above the 50 basement columns amounted to 15,000,000 lb., or 300,000 lb. per column.

At the time this structure was built, the idea of using light-weight aggregate on so large a scale was somewhat new in Chicago, as the result of which ordinary concrete was used. Nevertheless, the figures tell a convincing story.

Randall Committee Investigation

One of the most exhaustive investigations thus far made, on the economic value of light-weight concrete, was that conducted by Committee 406 of the American Concrete Institute, under the chairmanship of Frank A. Randall, consulting structural engineer, Chicago. The full report of the committee will be found in the March (1931) issue of the *Journal* of the American Concrete Institute.

Through the preparation of complete designs and estimates the Randall committee was enabled to make a definite comparison over a wide range. Designs and estimates covered six heights, including 5, 10, 15, 20, 25 and 30 stories, one set of plans having utilized reinforced concrete frames and the other structural steel frames fireproofed with concrete. Various weights of concrete were considered, namely, 150, 125, 100, 75 and 50 lb. per cu. ft. The cost of the superstructure concrete was figured at 30, 40 and 50 cents per cu. ft. The design was based on the proposed new building code for Chicago, which is closely in line with the working stresses recommended by the American Concrete Institute and the American Institute of Steel Construction.

Facts Established by Randall Committee

Inasmuch as light-weight aggregates suitable for high-strength structural concrete now commercially available produce concrete weighing around 100 lb. per cu. ft., and since designers usually figure the weight of ordinary concrete at 150 lb. per cu. ft., the estimates determined by the Randall committee for these two weights will be given in the paragraphs that follow:

Reinforced Concrete Building. (a) In reinforced concrete buildings with a 4-in. solid slab floor the percentage of reduction in tonnage of reinforcing steel where light-weight aggregate was used ranges from 20.0 per cent in the 5-story building to 22.9 per cent in the 30-story building.

(b) In reinforced concrete buildings with a concrete joist floor the reduction in tonnage of reinforcing steel ranges from 10.7 per cent in the 5-story building to 15.6 per cent in the 30-story building, in favor of the 100-lb. concrete.

Steel Frame Building. (a) In steel framed buildings fireproofed with concrete and having a 4-in. solid floor slab of reinforced concrete the reduction in tonnage of reinforcing steel ranges from 13.9 per cent in the 5-story building to 9.0 per cent in the 30-story building. The structural steel tonnage is reduced by 20.6 per cent in the 5-story building and 21.0 per cent in the 30-story building.

(b) In steel framed buildings fireproofed with concrete and having concrete joist floors the use of the lighter concrete reduces the tonnage of reinforcing steel by 13.3 per cent in the 5-story building, and 12.9 per cent in the 30-story building. The structural steel tonnage is reduced by 9.3 per cent in the 5-story building and 13.7 per cent in the 30-story building.

Each Building an Individual Problem

The designs and estimates prepared by the Randall committee, as well as the two previous instances mentioned in this article, show that each building constitutes an individual problem. Nevertheless, the figures indicate that the use of 100-lb. concrete instead of ordinary 150-lb. concrete in a building of reinforced concrete or of steel fireproofed with concrete will mean a reduction ranging somewhere from 10 to 20 per cent in the tonnage of steel. This range seems to hold for both the reinforcing steel and the structural steel.

Less definite figures are available on bridges, but it is believed that in a reinforced concrete arch the percentage of reduction in steel tonnage would be even greater than with buildings.

Adding Stories to Existing Buildings

It often happens that in a city whose building regulations have been modernized in comparatively recent years, some buildings that were built under older and very conservative code regulations can be increased in height under the newer regulations. In fact, this form of plant extension is likely to appeal to commercial and industrial concerns for the next few years, and it is a field that might well be cultivated by architects and engineers.

A recent illustration is that of the addition of a fifth story to the old 4-story building occupied by the Rapid Roller Company,* in Chicago. The original building, a concrete-fireproofed steel frame structure, was erected under the provisions of more conservative building regulations than those now in force in Chicago. Examination of the old plans disclosed that under present regulations some further weight could be added. If ordinary concrete had been used, however, the weight of an additional story would have been greater than the present building regulations could allow. By using Waylite, a light-weight processed slag aggregate, for both the fine and coarse aggregate in the monolithic concrete and in the precast concrete roofing slabs, it was possible to add the extra story. The monolithic concrete weighed 103 lb. per cu. ft. and that in the precast roofing slabs weighed 97 lb. per cu. ft. Here, then, was a case where the choice lay between using light-weight concrete or not building the addition at all.

More Stories Added

Another interesting illustration is that of the Chicago Screw Company building, to which four extra stories were added.† This is a flat-slab reinforced concrete building. Originally it was designed as a 4-story building carrying a live load of 250 lb. per sq. ft. At first only 2 stories were built, and in 1929 the company decided to add the remaining stories. In the meantime the company officials had reached the conclusion that a live load of 150 lb. per sq. ft. (instead of 250 lb.) would be ample for their requirements on the upper floors. Examination of the old plans followed, with the view of determining if 3 new stories might be added as a result of the reduced live load. Figuring on ordinary concrete, however, that could not be done. It was then disclosed that through the use of sandhaydite concrete weighing 115 lb. per cu. ft., and figuring on the reduced live load, 4 stories instead of 3 stories could be added. The 4 stories were added, and the completed building is now a 6-story structure.

To Play a Greater Part

Now that light-weight aggregates suitable for high-strength structural concrete are available over a considerable section of the country, it is reasonable to believe that light-weight structural concrete and light-weight concrete products will play an increasingly important part in building construction and in miscellaneous concrete products.

Purdue Road School and Show at Lafayette in January

The nineteenth annual Purdue road school will be held at Purdue University, Lafayette, Ind., beginning January 23 and continuing through the 27th. A two-day road show will form part of the program.

The school will be held under the direction of the Engineering Extension Department and the School of Civil Engineering, with the County Surveyors Association, County Highway Superintendents Association, the Indiana State Highway Commission, and the Highway Material and Equipment Association co-operating. Inquiries should be addressed to the Engineering Extension Department of the university.

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*See CONCRETE, October, 1932, page 10, for descriptive article.

†See CONCRETE, March, 1930, pages 13-14, for detailed illustrated article.

Home Improvement Committees in 78 Cities

Property improvement committees have been established in some 78 cities throughout the country since the beginning of 1932, according to a statement of the Home Modernizing Committee of the U. S. Department of Commerce. The purpose of these committees is to carry on local educational campaigns designed to encourage carefully-planned repairs and improvements to residential, commercial and industrial buildings.

These voluntary community campaign organizations include various civic groups co-operating with local business firms. Their activities have made it relatively easy for interested property owners to secure competent information on proposed plans, financial arrangements, estimated costs, and building materials.

The Home Modernizing Committee is composed of 17 voluntary members representing a cross-section of expert opinion in the housing field and acting as an advisory group of the Division of Building and Housing in the U. S. Bureau of Standards, Washington, D. C.

National Committee for Trade Recovery Aids R. F. C. Loan Applicants

By L. J. MULHEARN
Executive Secretary, National Committee for Trade Recovery, New York, N. Y.

THE trade recovery movement, sponsored by the Construction League of the United States through the agency of its National Committee for Trade Recovery, is one of the most important and far-reaching movements ever undertaken during peace time in our country.

The original purpose of the National Committee for Trade Recovery was twofold. Its first task was to secure support and action of Congress to provide for federal credit in the financing of state and local public works. This objective has been accomplished with a considerable measure of success. The Emergency Relief and Construction Act of 1932, formerly known as the Wagner Bill, is now the law of the land.

Urge Utilization of Funds Available

The National Committee for Trade Recovery, therefore, is now confronted with its second task, which is to carry on an educational campaign to convince public officials and our citizenry in general that trade recovery can be stimulated through the utilization of the moneys now available under the provisions of that Act for self-liquidating public works, low-cost housing and slum-clearance projects.

Some Active State Committees

We have state committees in 42 states and the balance of the states are now being organized. Each state committee is headed by a chairman whose duty it is to organize subcommittees in his state and to advise the various city and state officials of the benefits of the financing provisions of the Emergency Act. The further duty of the committee is to assist, in so far as possible, in helping forward applications for loans to the R. F. C. Of course, some committees are more active than others, and in many states they have done magnificent work. I would cite outstanding examples in the states of Michigan, New York, Indiana, Louisiana, Colorado, Nebraska and Kansas, as well as the two committees in California, one in the northern district and the other in the southern district. Excellent work is being done in many other states.

If public officials in any community have displayed lack of enterprise in the matter of forwarding applications for loans to construct worthy self-liquidating projects, members of the construction industry are urged to communicate with the writer with the view of obtaining the name of the chairman of the state committee concerned. Information will also be supplied on the preparation of applications, forms of agreement, and related matters.

The immediate problem is to list self-liquidating public works in each state, and urge or demand that public officials file promptly their applications with the R. F. C. at Washington for loans on sound public works projects. The executive committee of the N. C. T. R. has established and is maintaining contact with the recently appointed engineers' advisory committee of the R. F. C. as well as with the officials of the R. F. C. Board. The American Institute of Architects is co-operating by encouraging the passage of housing laws in various states.

Considerable work is also being done by the various state committees looking to the framing and passage of legislation in the respective states, which will enable the various political subdivisions further to take advantage of the self-liquidating provisions of the Act.

Will Stimulate All Lines of Industry

The public works program envisioned by the National Committee for Trade Recovery is the biggest peace-time engineering job this nation has ever tackled, and its benefits will undoubtedly be reflected in a substantial stimulation of business in all lines of industry.

The National Committee invites the co-operation of the architectural and engineering professions and the entire construction industry, as well as the general public, to assist in forwarding its program to stimulate trade recovery.

Complete literature and current information, including a list of our chairmen for the various state committees, are available at the headquarters of the National Committee for Trade Recovery, 330 West 42nd St., New York, N. Y.

How Concrete Improved Airports in 1932

By E. K. SMITH
Asst. Manager, Highways and Municipal Bureau, Portland Cement Association, Chicago, Ill.

ALTHOUGH some lines of business showed decreased activities, commercial aviation advanced during 1932, and several companies even declared themselves out of the red. Figures for the first nine months of the year showed a 49 per cent increase in air express over 1931, and 390,600 passengers carried on scheduled flights as compared with 327,211 in 1930. The number of passengers carried in non-scheduled flights, of course, runs the number into millions. Air mail showed a slight decrease about the time the increased postage rates became effective, but was again increasing in September.

Great Variety of Concrete Work

Concrete improvements were completed at many airports to serve the increased demands of air traffic. Contracts ranged from one or two hangars to the completion of the concrete sea-wall and start of the major airport buildings at Shushan Airport in New Orleans. As might have been expected, concrete paving of roads and aprons was of common occurrence to provide a durable, all-weather, easily illuminated surface for the planes and cut down field maintenance.

Apron 75 ft. wide and 3,000 ft. long, at Langley Field

Outstanding Examples of Construction

Muskegon, Michigan, for example, placed 1,000 sq. yd. in an apron 600 ft. long by 48 ft. wide, and San Diego completed 5,319 sq. yd. of concrete in pavement in the drive and parking areas before the administration building.

Outstanding among the municipal improvements was the paving of three runways 100 ft. wide and running up to 3,000 ft. long at Cincinnati Municipal Airport, making a total, with aprons, of 91,000 sq. yd. paved with concrete during the year at this field.

For the first time, paving was a major improvement at government, army and navy fields this year, as grading and drainage approached completion. Concrete pavement was widely used for extensive aprons, for the paving of streets and roadways in the barracks and warehouse areas, and for the beginning of runways to be extended later. Over 300,000 sq. yd. of concrete pavement was placed this year at Maxwell, Langley, Barksdale, Selfridge and Mitchell Fields alone.

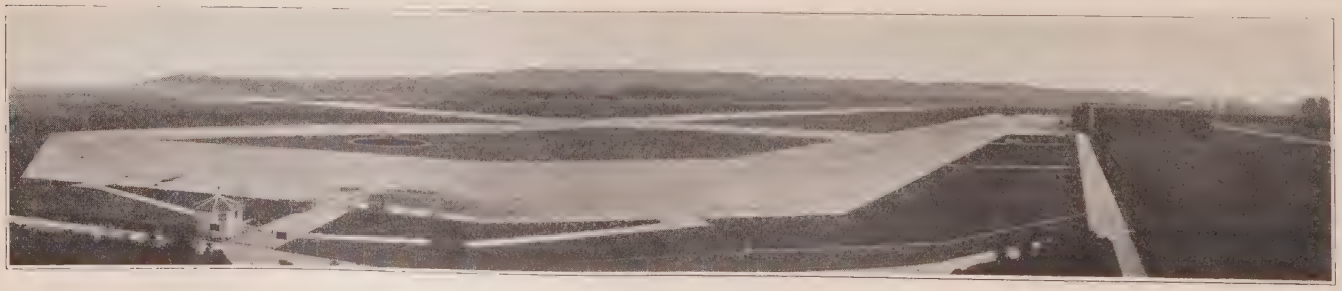
The great apron at Selfridge Field is 75 ft. wide by 3,500 ft. long. Barksdale Field paving includes the main apron 50 ft. wide by 3,000 ft. long and 5 runways leading off from the apron 150 ft. wide and 420 ft. long. Buildings at these airports also involve a large amount of concrete construction for floors, foundations and framing, the most striking probably being the great hangar for lighter-than-aircraft at Sunnyvale, California, which includes 280,000 sq. ft. of floor area.

As air traffic increases, the need for improved airports must increase with it. The truth of this assertion is well demonstrated in the illustration below, showing several concrete runways of 9-7-9 cross-section, each 100 ft. wide, and from 2,500 to 3,000 ft. long.

3,500,000 Man-Hour Job in Mississippi River Bridge Project

A total of 3,510,000 man-hours of work will be provided by the $14,000,000 railroad and vehicular bridge across the Mississippi River at New Orleans, construction of which is to start within the next few weeks, according to an estimate of the Reconstruction Finance Corp.

It is also estimated that 62,000 tons of steel will be used, together with 300,000 bbl. of cement, 185,000 cu. yd. of gravel, 100,000 cu. yd. of sand, and 2,200 cu. yd. of granite masonry.



EDITORIAL

Rough Seas Ahead for Highway Funds

THE addition of 82 million square yards of concrete to the paved road system of the United States in 1932 is an accomplishment that few would have predicted at the middle of the year. That is about 78 per cent of the record yardage of nearly 112 million reached in 1931—a very favorable comparison, all things considered. It means the equivalent of 8,240 miles of 18-foot concrete pavement added to the country's highest type of road.

What our state and county highway departments accomplished in 1932 was accomplished in the face of enormous difficulties—demands for reduction in taxes through reduced public construction; opposing demands for increased public construction to provide employment; demands for cheaper types of road in order that more mileage might be built; and diversion of gasoline tax funds to purposes other than road building.

What may be accomplished in 1933 will depend in large measure on the success attained in stemming the flow of diversion of highway funds. This diversion, as pointed out in an article by E. M. Fleming, in this issue, reached menacing proportions in 1932. Only the utmost vigilance and whole-hearted cooperation between highway officials and the construction industry will prevent still greater diversion in the coming year.

With 41 state legislatures going into regular session this month, only the aroused interest of the army of motorists will hold legislative raids in check. The task of arousing that interest comprises the work cut out for those who believe the gasoline tax should be applied to its intended purpose.

New Products and New Markets

IT is well that the annual meeting of the Concrete Masonry Association, to be held in Chicago on February 23, will give an important place in its discussions to subjects dealing with new products and new markets. Evidence has come to hand which testifies to the interest in these subjects now prevailing among products manufacturers.

Early in November the head of a large equipment company that manufactures concrete products machinery started on a business trip, scheduled to last four or five days, intending to call on a few of his agencies.

In reality the trip was extended to seven weeks, during which he called on practically all of his agencies east of the Rocky Mountains.

The cause back of this great extension of a business trip was the fact that the equipment manufacturer found concrete products manufacturers far more hopeful than had been expected. Some of them are looking for more business in 1933 in their regular lines, and many are interested in the possibilities of new and special products. They are replacing some of their old and worn-out equipment, getting ready for at least a moderate volume of business.

The convention program of the Concrete Masonry Association evidently is on the right track.

The Building Congress Program

THE scope of the construction industry which will be represented at the Highway and Building Congress, to be held in Detroit during the week of the Road Show, promises well for closer team work in this industry.

Pooling of the collective efforts of the various branches of the entire industry in the creation of a common program will go far toward restoring construction to a normal status.

It is the belief of the leaders of the 22 national associations now enrolled as participants in the Congress that the concerted program which they have launched will result, in time, in giving the construction industry even a larger place than it now occupies in the business structure of the nation.

Concrete construction in all its phases will play an increasingly important part in this new development. It is a development that deserves support.

No Logical Place for Cheap Roads

GOVERNOR PINCHOT of Pennsylvania has written to the governors of the 47 other states, telling them that his state is considering further limitation of weight and length of motor trucks and trailers operating on state highways.

Governor Pinchot has been a consistent advocate of "cheaper" types of highway pavements. It is only logical that, having taken a definite stand for the cheaper and less rugged types of pavement—types of construction that were cast aside by some states years ago because of their inability to stand up under modern motor freight traffic—he should be the first to urge reduction of allowable truck weights. Such reduction may be necessary to save the lighter pavements.

Men who can visualize the future trend of motor truck traffic, eventually as an adjunct to the railways rather than in competition with them, will not make the mistake of building roads that will break up under that traffic. There is no logical place for "cheap" roads in our highway systems.

PROGRESS—In a Page

◀ **Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.** ▶

Approve Revised Simplified Practice for Concrete Building Units

THE required degree of support, by all interests in the industry, has been accorded simplified practice recommendation R32-32, concrete building units, as revised by the industry's standing committee at a meeting held on March 1, 1932, according to an announcement by the division of simplified practice of the United States Bureau of Standards, Washington, D. C.

In the modified simplified schedule, the length dimension for three items was changed from the nominal dimension of 12 in. to the actual dimension of 11¾ in.; the maximum permissible variation for block and tile, over and under the given dimensions, was placed at ¼ in.; and in the case of concrete brick, it was decided to follow the tolerances prescribed by the American Society for Testing Materials in connection with clay and sand-lime brick masonry units, so that the tolerances of concrete brick will be 1/16 in. in height, ⅛ in. in width, and ¼ in. in length.

The revised recommendation became effective on December 15, 1932. Copies may be obtained at 5 cents each from the Government Printing Office, Washington, D. C.

Requirements for Masonry Cements

THE American Society for Testing Materials has published its Tentative Specifications and Tests for Masonry Cement (C 91-32 T), accepted as a tentative standard at the annual meeting in 1932.

Among the various requirements, the fineness must be such that the residue on a standard 200-mesh sieve does not exceed 20 per cent, by weight. The average compressive strength of 2-in. mortar cubes made of one part of masonry cement and three parts of standard Ottawa sand, by weight, shall be not less than 175 lb. per sq. in. at the age of 7 days. The 28-day strength shall be not less than the strength at 7 days.

Criticisms of these tentative specifications are invited, and should be addressed to Geoff. A. Saeger, secretary of Committee C-1 on Cement, 7417 Delmar Boulevard, St. Louis, Mo.

Forms for Floors of Concrete Joist Construction

UNDER date of October 15, 1932, the Division of Simplified Practice of the U. S. Bureau of Standards issued its Simplified Practice Recommendation R87-32, headed "Forms for Concrete Joist Construction Floors."

This revised standard supersedes the former standard R87-29, issued in 1929, and it has been designated by the American Standards Association as American Standard A48-1932.

In the revised standard several filler widths have been eliminated. Copies of this 14-page pamphlet may be obtained, at 5 cents each, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Revise Simplified Practice Covering Steel Reinforcing Spirals

SIMPLIFIED practice recommendation R53-32, a revision of an earlier program on the simplification of steel spiral rods for concrete reinforcement, has been accepted by members of the industry, according to an announcement by the division of simplified practice of the Bureau of Standards.

The original recommendation was drafted by the industry and made effective in 1926. It reduced the variety of rod diameters to four. In the present revision these diameters have been retained, and there are also shown the corresponding cross-sectional areas.

The new schedule became effective December 15, 1932. Copies may be obtained at 5 cents each from the Government Printing Office, Washington, D. C.

Mineral Resources of Massachusetts

THE first comprehensive official report on the mineral resources of Massachusetts which has been made for the state in many years has been prepared by Irving B. Crosby, consulting geologist, for the Massachusetts Industrial and Development Commission, Room 482, State House, Boston, Mass.

This report is based upon existing data, and no field work was done for this specific purpose; but numerous books, articles and reports were searched for information pertaining to mineral resources and much unpublished information was used.

Building stone, stone suitable for concrete aggregates, sand, gravel and clay deposits, and deposits of special forms of clay such as kaolin and fuller's earth, are some of the subjects covered in the report.

Index to A. S. T. M. Standards

THE 1932 Index to A. S. T. M. Standards and Tentative Standards is available for distribution. This is designed to be of service both to those familiar with A. S. T. M. standards and those who are not. Its value to the former group is in locating any specification or method of test in the bound Society publication in which it appears. To both groups the index is a very convenient reference in ascertaining whether or not the Society has issued any standards on a specific subject.

Copies are furnished without charge to those who send a request to Society headquarters, 1315 Spruce Street, Philadelphia.

Co-Ordination of Basic Principles of Concrete Mixtures

Law of Cement Content, Yield of Absolute Volumes, and Law of Aggregate Content Explained in Ninth Article of Series on Concrete Technology

IX—Needed Laws of Mixtures and Known Fundamentals (Continued)

By JOSEPH A. KITTS
Consulting Concrete Technologist, San Francisco, Calif.

THE water-cement ratio strength law is not definite as a formula of mixtures since it involves two unknowns—the quantities of cement and water in a unit volume of concrete. Before it is practicable to employ it with essential accuracy it is necessary to know, definitely, the amount of either cement or water in a given volume of concrete. As cement is the strength-producing ingredient, it is logical to assume that it is most important to determine first the amount of cement in the unit of concrete. Then, since concrete is required of any practicable strength, maximum size of aggregate, and consistency (slump, flow), we need to know the law (or laws) of cement content for any size of aggregate, strength and slump of concrete—Requirement (1).

The Law of the Cement Content

The general equation of the cement content for concrete of any strength for given age, maximum size of aggregate and consistency (or slump), was not discovered until January, 1929; and the laws of variation of the equation constants for variations of maximum size, and of slump, were not determined until October, 1929. The cement content equation and constants for given conditions of technological control, age, cement and aggregate quality, maximum size of aggregate, and slump of concrete, were not published until November, 1929 (See "A Mathematical Method of Proportioning," CONCRETE, November, 1929). It is important to note, however, that the characteristic curve of variation of strength with cement content, for given cement and aggregate, consistency of mix, and age of concrete, is now plainly evident, in Series 31 and 120, *Bulletin 4*, S. M. R. L., 1919, when absolute volume of cement is substituted for bulk volume as the unit of measure.

It is a fair commentary on the bulk volume technique of proportioning, testing and analysis of concrete mixtures, to remark that this most essential law of mixtures was concealed by it for a decade, 1919 to 1929, and that this is characteristic of the history of the bulk volume technique, and accounts for the groping progress in concrete mixture research.

The general equation of the cement content for any strength is—

$$C = AB^{s} \qquad (38)$$

$$\text{or } \log C = S \log B + \log A \qquad (38a)$$

$$\text{or } \log C = SB' + A' \qquad (38b)$$

in which C is the absolute volume of cement in a unit volume of concrete; S (exponent of B) is the compressive strength at a given age; A and B are constants depending on age, physical and technological conditions; and A' and B' stand for log A and log B, respectively. It is shown, by the average results of Series 120 as given in Table 7, to be true for absolute volumes of cement greater than 5 per cent of the volume of concrete, or, for cement contents in excess of 260 lb. per cu. yd. Therefore, it is satisfactory for concrete of strength exceeding 1,000 lb. per sq. in. For less than 5 per cent cement, the equation is on the safe side of the actual strength.

TABLE 7. AVERAGE DATA ON SERIES 120—BULK VOLUME AND ABSOLUTE VOLUME RELATIONS—COMPARISON OF EMPIRICAL EQUATION AND TEST VALUES OF STRENGTH AND YIELD—DENSITY OF CEMENT—CEMENT CONTENT

Given values are averages of all consistencies and all cements as shown in Tables 23, 25, 32 and 33, Bulletin 4, Structural Materials Research Laboratory, Lewis Institute.

	Given Values					Calculated Values					
Tab. No.	R Bulk vol. of aggregate to unit bulk vol. of cement	W/C Vol. of water per unit bulk vol. of cement	Y Yield of concrete per unit bulk vol. of aggregate	K_a Density of absolute vol. of solids per unit vol. of concrete	S Compressive strength of concrete lb. per sq. in., at 28 days	S' Compressive strengths by law of cement content equation Eq. (38d)	C_v Absolute vol. of cement per unit vol. of concrete by Eq. (34a)	C' Lb. of cement per cu. yd. of concrete by Eq. (35a)	C_a Indicated density of cement by Eq. (33)	K_y Yield of vol. of concrete to sum of absolute vol. of ingredients Eq. (36a)	K'_y Yield of absolute vol. by law of yield equation Eq. (37)
1	∞	——	1.000	0.767	000	——	——	——	——	——	——
2	10	1.73	1.027	0.794	613	407	0.0472	247	0.484	1.039	1.028
3	7	1.35	1.038	0.806	1001	994	0.0667	349	0.487	1.009	1.012
4	5	1.08	1.067	0.810	1525	1517	0.0909	475	0.486	0.988	0.999
5	4	0.95	1.108	0.802	1791	1832	0.1093	572	0.486	0.984	0.991
6	3	0.825	1.179	0.788	2226	2216	0.1371	717	0.486	0.980	0.981
7	2	0.70	1.331	0.758	2720	2698	0.1822	953	0.484	0.979	0.969
8	0	——	∞	——	——	——	——	——	——	——	——

Employing the method of least squares and the given tabular values Nos. 3 to 7 (Table 7), the equation for this data is determined as—

$$\log C' = 0.000256\,S + 2.28845 \qquad (38c)$$

or

$$S = 3906\,(\log C' - 2.28845) \qquad (38d)$$

in which C' is the cement content in pounds per cubic yard of concrete, and S is the compressive strength at 28 days, based on average values for the ten K and L cements and the average of all consistencies, 1.29.

It is also evident, in Series 120, that the values of A and B vary with the age (see Fig. 12, p. 33, *Bul. 4,* S. M. R. L.). Thus, there is a system of laws based on Equation (38) with the constants A and B varying in some regular manner with age, maximum size of aggregate and consistency (or slump), for given aggregate, cement and technological conditions. The laws of variation of A and B are shown definitely in more recent research data and will be presented with the review of that data in a later chapter.

Analysis of Series 120

Conversion of bulk volume data of concrete mixtures to the absolute volume basis is readily accomplished provided we know the bulk volumes of the ingredients, their respective densities, and the volume of concrete in the mix; and, also, if we know the specific gravity and weights of the ingredients, and the volume of concrete resulting.

In Series 120 we have as given values the bulk volume and density of the mixed aggregate, the bulk volume and weight of cement, the ratio of volume of water to unit bulk volume of cement, the yield of volume of concrete on the basis of the bulk volume of the mixed aggregate, and the density of the concrete.

"Density," as used in concrete physics, is an appreciation of the absolute volume measure, as the "density" of concrete is the proportion of absolute volume of solids in the unit volume of concrete. This idea was introduced by Feret and the equation of density (See Eq. 11) was formulated by him prior to 1892.

The specific gravity and density of the cement is not given in Series 120, but it is possible to determine either one or both of these from the data given. That is, there are at least two mathematical equations of facts involving the two unknowns. The density of the cement is readily determined, from the averages of the given data, by the equations—

$$K_d = (C_d + 0.767\,R)/K_v \qquad (11a)$$

$$K_v = R \times Y \qquad (32)$$

and

$$C_d = (K_d \times R \times Y) - 0.767\,R \qquad (33)$$

in which K_d is the given density of the concrete, 0.767 is the given density of the aggregate, R is the given bulk volume of aggregate to a unit bulk volume of cement, Y is the given yield of concrete in terms of the bulk volume of aggregate, K_v is the volume of concrete in the mix, and C_d is the density (absolute volume in a unit bulk volume) of cement to be determined. The density of the cement is found by Equation (33) to be approximately 0.485. The average given weight of the cement per cubic foot bulk volume is 93.9 pounds.* The specific gravity of the cement is then determined by the equation—

$$C_g = 93.9/(C_d \times 62.4) \qquad (28a)$$

and is found to be 3.103.

The absolute volumes of cement, C_v, in a unit volume of concrete, for the bulk volume proportions 1:2, 1:3, 1:4, 1:5, 1:7 and 1:10, are determined by the equation—

$$C_v = C_d/K_v \qquad (34)$$

$$= C_d/(R \times Y) = 0.485/(R \times Y) \qquad (34a)$$

in which C_d is the average of the densities, of the cement, indicated by the data of the six mixes.

The weight of cement, in pounds per cubic yard of concrete, C', is readily determined from the data of Series 120 by the equation—

$$C' = (93.9 \times 27)/K_v \qquad (35)$$

$$= 2535.3/RY \qquad (35a)$$

in which 93.9 is weight in pounds of the cubic foot bulk volume of cement, K_v is the volume of concrete in the mix, R is the bulk volume of aggregate to 93.9 pounds of cement, and Y is the yield of concrete on the basis of the bulk volume of aggregate.

K_y, yield of concrete on the basis of the sum of the absolute volumes of ingredients, is readily determined from the given data of Series 120 by the equation—

$$K_y = K_v/(C_v + R_v + W_v) \qquad (36)$$

in which K_v is the volume of concrete produced by the mix, and C_v, R_v and W_v are the absolute volumes, respectively, of cement particles, rock particles and water, in the mix. This equation is based on Feret's law of the "elementary volumes" (see Eq. 10). The corresponding practical equation applying to the given data is—

$$K_y = RY/(0.485 + 0.767\,R + W/C) \qquad (36a)$$

These equations involve only the most simple physics and mathematics and should be easily understood by the technical student. The various relations on the basis of absolute volumes of ingredients are simplified and clarified in one's mind as soon as the general conception of the absolute volume composition of the mix replaces the old bulk volume idea of proportions.

Law of Yield of Absolute Volumes

The law of yield of combinations of ingredients—our Requirement 6—was stated quite accurately by Feret, about 1892, as

$$c + a + w + v = 1.0 \qquad (10)$$

in which c, a, w, and v are the absolute volume proportions of cement, aggregate, water, and air voids, respectively, in a unit volume of concrete. Feret was experimenting with comparatively dry mixes, which entrapped sufficient air to offset the volume of cement going into solution with the mixing water. Accordingly, the sum of the absolute volumes of ingredients (exclusive of air voids) was less than the volume of concrete produced; and this difference was necessarily made up by air voids. However, we find in subsequent research of comparatively rich and wet mixtures that the volume of concrete is consistently less than the sum of the absolute volumes of ingredients, aggregate, cement and water, despite the fact that all mixtures entrap some air. This is shown in Table 7 under K_y for tabular values Nos. 4, 5, 6 and 7, the ratio of concrete volume to total absolute volume decreasing with increase of cement content. It is apparent, therefore, that a portion of the cement solids go into solution with the mixing water, and that cement solubility is offset somewhat by entrapped air, the yield of total absolute volumes varying from about 4 per cent plus in the lean mixtures of average consistency to 4 per cent minus in the rich mixtures of the same consistency.

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*The proportions in Series 120 assume the weights of all cements to be 94 lb. per cu. ft. while the average weight is 93.9 lb. per cu. ft. bulk volume. The difference of one-tenth of one per cent is ignored in this analysis.

As it is important in the production of ready-mixed concrete to control the volumes of concrete delivered within an accuracy of one-half of one per cent of correct volume, and quite essential in the control of quality, a simple method of compensating for the difference between entrapped air and cement solubility is a practical necessity. We need to know the ratio of volume of concrete to the sum (total) of the absolute volumes of the ingredients—that is, the "yield of the absolute volumes" as expressed by Equation (36).

Series 120 shows test values of K_y, for average consistency, as given in Table 7, varying from 1.039 for 247 lb. of cement to 0.979 for 953 lb. of cement per cu. yd. of concrete. Plotting K_y against pounds of cement per cubic yard of concrete, both to logarithmic scale, the relation is shown as practically a straight line, and that the yield of the absolute volumes for concrete of a given consistency is dependent largely (if not wholly) on the cement content. The equation of this relation is—

$$K_y = mC^n \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (37)$$

or

$$\log K_y = \log m + n \log C \quad . \; . \; . \; . \; . \; . \quad (37a)$$

in which C is the cement content by absolute volume and m and n are constants depending apparently on consistency of mix and water solubility of the cement.

Writing this equation with the six sets of values of C' and K_y given in Table 7 and employing the method of least squares, the practical equation for average cements and consistencies of Series 120 is determined as—

$$\log K_y = 0.117518 - 0.0441138 \log C' \quad . \quad (37b)$$

in which C' is pounds of cement per cubic yard of concrete.

The law of yield of combinations of ingredients—satisfying our Requirement 6—is, then,

$$K_y = K_v/(C_v + R_v + W_v) \quad . \; . \; . \; . \; . \quad (36)$$

in which the approximate values of K_y may be predetermined by Equation (37b) for concrete of average consistency.

Law of the Aggregate Content

Knowing the law of the cement content (Eq. 38), the law of the water-cement ratio (Eq. 21) and the laws of yield of absolute volumes (Eqs. 36 and 37), the law of the aggregate content is quite obviously—

$$R_v = (K_v/K_y) - (C_v + W_v) \quad . \; . \; . \; . \quad (36b)$$

in which R_v is the absolute volume of aggregate in K_v volume of concrete, and C_v and W_v are absolute volumes of cement and water, respectively, as determined by Equations (21), (36), (37) and sub-numbers.

Equation (36b) satisfies our Requirement 3 when Requirements 1, 2 and 6 are known.

Resumé

The preceding review of mixture research has brought forth at least preliminary bases for our Requirement (1), the law of the cement content; Requirement (2), the law of the water content; Requirement (3), the law of the aggregate content; Requirement (4), the law of the fineness modulus; Requirement (5), the grading equation for three or more aggregates; and Requirement (6), the law of the yield of combinations of ingredients.

Requirements (1), (2), (4) and (5) require more definition and elaboration, which will follow.

(To Be Continued.)

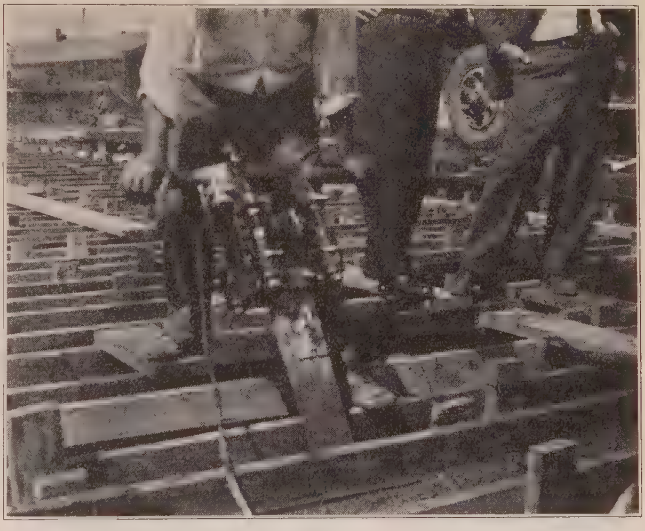
Use High-Frequency Vibration in Casting Concrete Piles

Electrically Operated Tool Produces 3,600 Vibrations per Minute

The increasing recognition of the value of high-frequency vibration in the placing of fresh concrete is shown by the use of these tools in special products such as reinforced concrete piling, concrete telephone poles, and similar concrete products.

Readers of Concrete are familiar with the use of high-frequency vibrators in the manufacture of ordinary concrete building units and of cast stone, in placing structural reinforced concrete, and concrete in large masses, such as dams.

The same principle is applied to the placing of concrete of shallow depth, as in floor slabs. Similarly, as the illustration shows, vibrating tools can be adapted to the requirements in the case of concrete piling. The tool shown in the illustration is equipped with a spud and handle for the use of the operator in vibrating the fresh concrete in the pile forms. This tool is known as an electro-magnet vibrator, manufactured by the Syntron Co., of Pittsburgh. It operates at a frequency of 3,600 vibrations per minute on a 60-cycle alternating current, causing the concrete to flow around the reinforcement in a dense mass.



High-frequency vibrator used in casting reinforced concrete piles

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Southwest Road Show

The 1933 Southwest Road Show and School is scheduled to be held at Wichita, Kansas, February 21 to 24, according to Fred G. Wieland, general manager.

One-Yard Trucks Haul Concrete for 3-Mile Overhead Highway

Mix Concrete at Central Plant
Trucks Operate on Time Schedule
Great Metropolitan Highway Link Opened

THE great overhead highway built from Jersey City to Newark as the most important link in the road from Elizabeth, N. J., to the mouth of the Holland tunnel, stands as definite evidence that highway construction is continuing in spite of diversion of funds, reduced income, and various other obstacles.

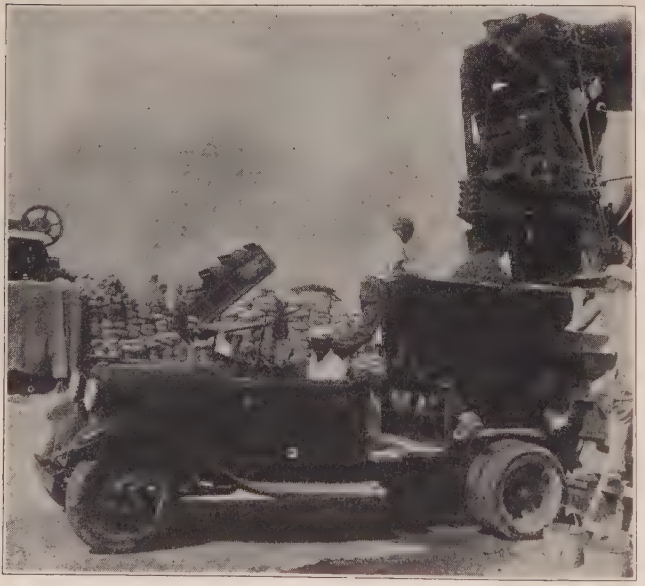
Structure Is 3 Miles Long

This 4-lane structure, 3 miles long and with heights ranging from 40 ft. to nearly 200 ft. above the general ground level, has been completed at a cost of $18,000,000 and was opened to traffic early in December.

Foundations for the structure were extended to bedrock, lying at an average depth of 100 ft. and a maximum of 140 ft. In this length of 3 miles the structure required 90,000 tons of steel and 250,000 cu. yd. of concrete.

Mix Concrete at Central Plant

An interesting feature of the concrete work was seen in the methods employed in mixing, transporting and placing that part of the concrete comprising the reinforced concrete deck construction.



Trucks receive batch on regular time schedule

The Fredburn Construction Corp., of Staten Island, N. Y., who had the contract for this work, established a central concrete mixing plant equipped with two 1-yd. mixers, together with mechanical charging equipment which permitted a complete cycle of charging, mixing and discharging in 1¾ minutes.

The concrete was transported from the mixing plant to the point of deposit by a fleet of 11 Ford trucks each having a capacity of 1 cu. yd. The trucks, as the illustrations show, were fitted with special side-dump bodies.

Transporting concrete over catwalks on deck of overhead highway

Mixing and hauling operations were established on a time schedule. A bell was sounded as each batch was ready for discharge from the mixer. In the meantime a truck was spotted in position to receive the batch and to transport it to the point of deposit, running at relatively high speeds over catwalks of planks laid on the network of steel reinforcement in the deck structure, high above the ground.

The design of the mixing plant and the selection of the mixing and hauling equipment was in accordance with the recommendations of W. S. Jones, chief engineer of the Fredburn Construction Corp.

Experimental Concrete Pavement Has 20-Year Service Record

An article in the October issue of *Public Roads*, published by the United States Bureau of Public Roads, describes and illustrates the present good condition of the portland cement concrete sections of an experimental pavement laid in Connecticut Avenue, Washington, D. C., in the fall of 1912 and the spring of 1913.

Three sections (experiments 3, 4 and 5, north of Bradley Lane) were built of portland cement concrete, the article states. A portion of the work was done in the fall of 1912 and the sections were completed in May, 1913.

The concrete on experiment 5 was composed of a 1:1¾:3 mix. Gravel, limestone, and traprock were used as coarse aggregate in different sections of the experiment.

The thickness of the pavement is 6 in. throughout. The cost of the surface was 142.29 cents per sq. yd. In 1922 this experimental section was surface-treated with a hot application of 0.26 gal. of refined coal tar and pea gravel. This mat surface has now entirely disappeared.

The subgrade on which the Connecticut Avenue experimental road was constructed is a silty loam with varying percentages of mica. Excessive mica causes detrimental elasticity in soils, and this fact may account in part for the large amount of cracking which has occurred in the concrete sections.

Public Utilities Destroy Drainage

Defective drainage has had a great deal to do with the damage to the concrete. In February, 1929 (see *Public Roads*, vol. 11, No. 4, June, 1930), immediately after a heavy rain, it was noted that a considerable volume of water was flowing to the surface of the concrete sections through the cracks. This condition was found throughout the concrete portion of the experiment, although it was most severe on experiment 3. It was also observed that the sewers were not receiving any flow from either side drain or through the cross drains. Upon digging down into the French drains it was found that wherever one of the utility companies had made a cut through the drain line, it had failed to replace either tile or stone and had backfilled the trench with earth, thereby effectively destroying the drainage system. It was learned from the records of the sanitary commission that most of the service connections were made in 1922. It is also a fact that the cost of maintaining the concrete sections has materially increased since that year. The total cost of maintenance to date, including the surface treatment in 1922, amounts to 37.71 cents per sq. yd.

The concrete portion of the Connecticut Avenue experimental road cannot be regarded as a particularly successful example of concrete road construction even for the early day in which it was built; and great advances have been made, in both knowledge and technique, in that time. However, the pavement is still in service under an average traffic of about 3,000 vehicles per day.

Diagonal Expansion Joints for Concrete Highways

Engineer Thinks Riding Qualities Would Be Improved—Analogy in Railroad Crossings

By H. R. NEWSOME
Greeley, Colorado

Have you ever ridden along a concrete highway in which the slight raise at each expansion joint caused the car to throw the people in the back seat almost through the top? I have, and I have wondered if it were not possible to place the expansion joint at an angle of about 45 degrees to the center line. Thus the two wheels of the car would not hit the raise at the same time, and the ease of riding would improve immensely.

It is easy to observe that the wheels on one side of a car may hit a large obstacle without giving the discomfort that a much smaller object will cause if hit simultaneously by the two front or the two rear wheels. Railroad crossings at right angles to the center line are very rough, while those which are less than right angles are not nearly so rough.

It seems to me that expansion joints could be placed at an angle to the center line which would give greater riding comfort and still give the proper expansion. We are building faster cars and supposedly faster highways, but I know of many where the speed is limited because of the roughness caused by the tar in the expansion joints. I admit that this is a poor highway, but diagonal joints would improve its riding qualities a great deal.

Even on the newest highway I have noticed that a car traveling at high speed is caused to rock considerably because of the slight raise at the joints. I feel that if the joints were at an angle less than 90 degrees the car would ride much smoother.

I have not only considered this from the view of the car driver, but also as an engineer. I have designed highways for three different states, and see nothing so serious as to prohibit its adoption.—[Comments on this suggestion are invited.—The Editors.]

Coming Conventions

January 16-18—Associated General Contractors of America, fourteenth annual convention. Statler Hotel, Washington, D. C.

January 16-18—National Crushed Stone Association, sixteenth annual convention. Book-Cadillac Hotel, Detroit, Mich.

January 16-20—American Road Builders Association, annual convention and road show. Statler and Fort Shelby hotels, and Municipal airport.

January 16-23—Highway and Building Congress. First annual meeting. Detroit, Mich.

January 17-18—National Sand and Gravel Association, seventeenth annual convention. Book-Cadillac Hotel, Detroit, Mich.

January 18—National Ready-Mixed Concrete Association, third annual convention. Book-Cadillac Hotel, Detroit, Mich.

January 18-21—American Society of Civil Engineers, eightieth annual meeting. New York City.

January 23-27—Purdue Road School, nineteenth annual session. Purdue University, Lafayette, Indiana.

February 21-24—American Concrete Institute, twenty-ninth annual convention. Palmer House, Chicago, Ill.

February 23—Concrete Masonry Association, third annual convention. Palmer House, Chicago, Ill.

February 27-28—American Concrete Pipe Association, twenty-sixth annual convention. Royal York Hotel, Toronto, Ontario, Canada.

June 26-30—American Society for Testing Materials, annual meeting. Stevens Hotel, Chicago, Ill.

June 26-July 1—American Society of Civil Engineers, annual convention. Chicago, Ill.

High Pressure Steam Curing Under Study for Eight Years

Tests at University of Saskatchewan Supply Further Contribution to Pearson and Brickett Report—Why Some Aggregates Are Unsuitable

STUDIES on the effects of curing portland cement mortars and concrete in steam under pressure have been in progress at the University of Saskatchewan during the last eight years as a part of an investigation of the action of sulphate waters on cement and concrete. This work was initiated by a committee of the Engineering Institute of Canada, under the chairmanship of Dean C. J. Mackenzie, and has been carried on with the financial support of the National Research Council of Canada and other public organizations. The results which have been obtained enable one to explain some of the observations recorded by Pearson and Brickett in their paper presented to the last annual meeting of the American Concrete Institute.

The July (1932) issue of *Concrete*, pages 19 and 20, contains an abstract of a paper on high-pressure steam curing, presented by J. C. Pearson and E. M. Brickett before the 1932 annual meeting of the American Concrete Institute.

In the October (1932) *Journal* of the A. C. I. the Pearson-Brickett paper is discussed by several other investigators, including T. Thorvaldson, professor of chemistry, University of Saskatchewan, Saskatoon, Canada. Prof. Thorvaldson's interesting discussion is based on the results obtained in similar tests at this university, and is given here as a further contribution to the subject.—The Editors.

First Effect Is Adverse

It has been found[1] that the first effect of curing in steam under pressure is to decrease the tensile and compressive strength of the specimen. This is quickly followed by the well known increase in strength. For short periods of steam curing (1 to 12 hours) there is usually an acceleration of the increase in strength as the temperature of the saturated steam rises up to 200 to 225 deg. C.; for longer periods of steam curing there is an optimum temperature for obtaining high strengths which is usually below 200 deg. C. The rate of increase of strength and this optimum temperature also vary with the composition of the cement and the time of damp-curing which the specimen has been subjected to before exposure to steam.

Thorvaldson and Shelton[2] found that during the first few hours of the steam curing of a sand mortar made from a portland cement high in tricalcium silicate, crystals of calcium hydroxide appear in the specimen, followed on longer steam curing by the disappearance of these crystals and the gradual formation of another crystalline product. Later work by V. A. Vigfusson and the writer has shown that this second crystalline product is a hydrated calcium silicate formed mainly by the interaction of the lime, liberated by the hydration of the tricalcium silicate in the cement with the silica of the aggregate, and that this same crystalline product is formed during the manufacture of sand-lime brick. It is the opinion of the writer that the increase in strength produced by the curing of portland cement mortars and concrete in steam under pressure is mainly due to this reaction, although it has been shown that other reactions mentioned below probably contribute materially to the result.

This throws light on several observations noted and discussed by Pearson and Brickett; for instance, the effect of varying the cement content, the low increase in strength of neat cement specimens, and the effect of using a calcareous instead of a siliceous aggregate. These observations are in agreement with results previously obtained in the writer's laboratory. It is evident that when the aggregate is calcareous or when dealing with specimens of neat cement there can be no development of strength, due to the formation of hydrated calcium silicate by reaction between the lime liberated during hydration and the aggregate. The effect of the cement content is also in accordance with what one would expect on the basis of a reaction between the lime and the silica which takes place at the interface. For the richer mixes the limiting factor is the amount of surface of the aggregate, while for lean mixes the limiting factor is the quantity of cement, so that the strength developed per pound of cement per cubic foot increases with decreasing cement content and tends to reach a maximum for lean mixes at least at the higher temperatures of steam curing where the reaction is fairly complete. This reaction between free lime and the aggregate probably increases in importance as the time of the preliminary damp curing is increased.

There are other reactions which play an important part in the curing of portland cement concrete in steam under pressure. The formation of the hexahydrate of tricalcium aluminate[3] in steam under pressure in preference to the higher anisotropic hydrate formed at room temperature may play a part in the initial stages. Norman B. Keevil, working in this laboratory, has shown that both tricalcium silicate and β-dicalcium silicate in steam under pressure form crystalline hydrates without any liberation of free lime. This process is probably only second in importance to the reaction between the free lime and silica in the development of strength of portland cement mortar on steam curing and may be of primary importance in concrete made from cements high in dicalcium silicate, or specimens exposed to steam after very short periods of preliminary damp curing. Further, Douglas T. Mather, also working in this laboratory, has shown that the compound $4CaO.Al_2O_3.Fe_2O_3$, which is probably present in portland cement, hydrolyzes very slowly in steam giving the hexahydrate of tricalcium aluminate, anhydrous ferric oxide and free lime, and that the velocity of this reaction increases with the temperature of the saturated steam. This reaction may be, at least in part, the cause of the falling off in strength which generally takes place on steam curing of specimens for long intervals of time, and which at the higher pressures may occur within 24 hours with a second increase in strength following this.

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[1] Thorvaldson, Vigfusson and Wolochow. *Can. J. Research*, Vol. 1, 370-374 (1929).

[2] *Can. J. Research*, Vol. 1, 148 154 (1929).

[3] Thorvaldson and Grace. *Can. J. Research*, Vol. 1, 36, 1929. Thorvaldson, Grace and Vigfusson. *Can. J. Research*, Vol. 1, 201, 1929.

To sum up: The loss in strength at the beginning of steam curing of portland cement mortars or concrete is probably due to changes in the crystalline form of hydrated tricalcium aluminate and to physical stresses during the expansion of the specimen. The increase in strength which rapidly follows this is due to the formation of a crystalline hydrated calcium silicate by reaction of free lime with the siliceous aggregate and to the direct formation of crystalline hydrates of the silicates of calcium, the formation of a hydrate of tricalcium silicate being mainly responsible for the early increase of strength while the hydration of dicalcium silicate is responsible for the later more gradual increase. Later losses in strength, especially at higher pressures of steam, are probably due to the hydrolysis of the compound $4CaO.Al_2O_3.Fe_2O_3$, and possibly to secondary changes in the calcium hydrosilicates.

Finds Strength Permanent

The question whether the high strengths obtained by steam curing are permanent in character is an interesting one. Tests made in this laboratory, extending over from three to eight years, indicate that steam-cured portland cement mortars stored in water retain their strength, and that specimens which have been subjected to short periods of steam curing continue to increase slowly in strength and ultimately attain as high strengths as specimens cured in water. The enormous increase in the stability of steam-cured mortars and concrete in sulphate waters has been discussed elsewhere.[4]

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[4] Thorvaldson, Vigfusson and Wolochow. *Can. J. Research*, Vol. 1, 359, 1929.

Congress, Exhibits, Meetings at Detroit

January 16 is the opening date of the Highway and Building Congress at Detroit as well as the first meeting day of part of the twenty odd participating organizations holding their annual conventions or special group meetings during that week.

Railroad fares of one and one-ninth of the one-way fare for the round trip have seen set.

Probably the principal event of the first day will be the opening of the Highway and Building Exposition to be held under the auspices of the American Road Builders Association at the Municipal Airport for five days.

At the same time will be held the Joint Exposition of Machinery, Equipment and Supplies by the crushed stone, ready-mixed concrete, and the sand and gravel groups. This show will be housed at the Book-Cadillac Hotel.

Organizations taking an active part in this five-day gathering are given in the accompanying list. Some of the other organizations, of an allied character, who are lending their sponsorship, are as follows: American Association of State Highway Officials, American Concrete Institute, American Institute of Consulting Engineers, Canadian Good Roads Association, National Highways Association, National Lime Association, and the Wire Reinforcement Institute.

PARTICIPATING ORGANIZATIONS

Organization	Annual Meeting	Dates	Hotel Headquarters
American Road Builders Association	Thirtieth	January 16-18	Statler and Fort Shelby
American Society of Municipal Engineers	Thirty-eighth	January 16-18	Statler
Associated Equipment Distributors	Fourteenth	January 15-16	Statler
Associated General Contractors of America	Fourteenth	January 16-18	Statler
Construction League of the United States		January 21	Statler
Highway Research Board	(Executive Committee)	January 18	Fort Shelby
International Assn. of Public Works Officials	(Combined with City Officials sessions)	January 17	
Materials Handling Institute and Materials Handling Division of A. S. M. E.		January 18	
National Crushed Stone Association	Sixteenth	January 16-18	Book-Cadillac
National Ready-Mixed Concrete Association	Third	January 17-18	Book-Cadillac
National Sand and Gravel Association	Seventeenth	January 16-18	Book-Cadillac
Portland Cement Association	(Board of Directors and district engineers)	(To be selected)	Book-Cadillac

HOW TO DO IT

✦ Questions and Answers ✦
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Unloading Bulk Cement from Special Railway Cars

During past months several news items have appeared in CONCRETE *concerning the use of self-unloading railway cars for shipping cement in bulk.*

We operate a ready-mixed concrete plant and we would like to know what is needed in the way of mechanical equipment to receive cement from cars of the kind described.—S. K. A., Edmonton, Alberta, Canada.

Only very simple mechanical equipment is required to receive bulk cement shipped in either of the two types of self-unloading railway cars now in use. One of these types is a tank car, which is unloaded by its own mechanism, driven either by an electric motor built into the dome of the car, or by a gasoline engine located on the storage bin platform, the power being applied through a shaft provided for that purpose.

The second type of car is a hopper car which is unloaded by gravity.

With either type the cement is discharged beneath the car. For receiving the cement from the tank car, a portable screw conveyor is shoved under the car, above the rails, and conveys the cement horizontally to the boot of the bucket elevator, or to whatever facilities the purchaser has for filling his bulk cement bins. To receive cement from the hopper cars the arrangement is similar, except that inasmuch as the discharge of cement occurs at a lower level it is necessary to place the horizontal screw conveyor in a fixed position beneath the rails. Space is provided for the screw conveyor by spreading two of the track ties and excavating a small amount between ties. Here, again, the cement is conveyed horizontally to the boot of the bucket elevator.

To sum up, the mechanical equipment required for receiving cement from tank cars consists of a portable screw conveyor long enough to reach from the center of the car to the boot of the bucket elevator of the plant, and either a gasoline engine or an electric power connection to drive the unloading mechanism of the car. For receiving cement from a hopper car the equipment required consists of a fixed screw conveyor placed below the rails, between two spread track ties, and long enough to reach from the farther rail to the bucket elevator of the plant.

It should be understood, however, that relatively few railway companies have put either type of car into service. The cars are especially well adapted to the delivery of bulk cement to concrete products plants, ready-mixed concrete plants, and contractors' mixing plants, wherever such plants are supplied with railway sidings. These elements of the construction industry might find it well worth while to bring these matters to the attention of railway companies which do not now provide the service. The cars, of course, can be used for shipping not only cement, but practically all types of granular commodities, such as dolomite, pebble lime, hydrated lime, soda ash, mineral colors and numerous other materials.

Co-Operative Marketing Organization To Sell Concrete Products

The concrete products manufacturers' association, representing most of the manufacturers in two counties of this metropolitan section, is planning to stabilize prices in the effort to improve the present local situation in the industry.

We have in mind something similar to a plan inaugurated in Milwaukee four or five years ago. Where can we get authoritative information on that plan?—R. C. P.

The plan introduced by the Milwaukee Concrete Products Co-Operative Association is described in a series of three articles by D. R. Collins, published in CONCRETE in the issues of November and December, 1929, and in January, 1930. The articles mentioned contain full details regarding the form of the organization and the manner of its operation.

Federal Specification for Concrete Masonry Units

I understand the government has adopted a standard specification for the manufacture and use of hollow concrete masonry units.

From what governmental department may this specification be obtained?—C. R. E., Tacoma, Wash.

The specification to which you refer may be obtained in the form of a printed pamphlet, at 5 cents a copy, from the Superintendent of Documents, Government Printing Office, Washington, D. C. The title of this standard is "Specifications for Hollow Concrete Masonry Units," and its symbol designation is SS-C-621.

Information on Swimming Pools

I am a concrete contractor, and I would like to have some information on building a swimming pool about 50 by 100 ft. in plan and from 1½ to 12 ft. deep. Can you refer me to such information?—A. R. T., Fort Smith, Ark.

For the information of concrete contractors and others interested in the promotion and building of outdoor swimming pools, the Portland Cement Association, 33 W. Grand Ave., Chicago, has issued an illustrated printed folder and standard plan layouts and cross-sections of swimming pools. While these plans are not working drawings, they supply much information for use in the preparation of working drawings.

New Books and Pamphlets

Reinforced Concrete Frames

Continuous Frames of Reinforced Concrete. By Hardy Cross, professor of structural engineering, and Newlin D. Morgan, associate professor of architectural engineering, University of Illinois. Published by John Wiley & Sons, New York. Cloth cover, 343 pages, 6 by 9 in., illustrated with numerous design diagrams. Price $4.50.

The text of this book is written as an aid to structural engineers in visualizing and picturing deformations in frames. The book emphasizes the importance of these pictures and the elementary nature of the geometry involved in drawing them. In developing the methods the authors have made a sincere effort to utilize the common sense element in structural engineering design.

This volume is not a general treatise on the mechanics of statically indeterminate structures. No attempt is made to present all methods of analysis. On the contrary, the authors adhere closely to a small group of geometrical methods which have been evolved over a period of years, and which many engineers have already found of great value in practical design.

The scope of the work is indicated to some extent by the chapter headings, which include subjects such as the statics and geometry of deflected structures; moment distribution; maximum moments, shears and reactions in continuous girders; the analysis of rigid frames; construction and use of influence lines; and analysis of right arches of reinforced concrete.

Publication of this work constitutes a gratifying step toward the more exact analysis of engineering structures.

Fireproof Concrete Homes

Low-Cost Fireproof Concrete Homes, published by the Portland Cement Association, 33 W. Grand Ave., Chicago, Ill. Heavy paper cover, 24 pages, 8½ by 11 in. Illustrated with 17 concrete home designs and plans. Sent free on request.

This book contains suggestions for the design and construction of small houses estimated to cost from $2,700 to $6,600, exclusive of the lot and financing charges. This is offered free by the Portland Cement Association to meet the demand for facts about the building industry's work to effect dollars and cents reductions in home-building costs.

Estimated construction costs for the 17 suggested designs in the booklet average about $4,000, with several costing less than $3,000. An interesting feature is the first unit, costing only $2,700, of a "house that can grow." This consists of living room, kitchen, bedroom and bath. Later, when more room is required, a second unit costing about $2,650 can be built to make a complete 5-room house.

"When one wants to build any of these attractive homes," the foreword states, "he should show the sketch to an architect. Architects are experienced men upon whom the public can rely for advice and friendly co-operation. Working drawings and specifications for the suggested designs in this booklet should be prepared by architects."

Concrete builders and concrete products manufacturers, as well as architects, should obtain and make use of a copy of this well prepared book of plans and designs.

ORGANIZATIONS

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building, Washington, D. C.

American Concrete Institute; Harvey Whipple, Secretary, 641 New Center Building, Detroit, Mich. Twenty-ninth annual convention, Feb. 21-24, Palmer House, Chicago, Ill.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 West Grand Ave., Chicago. Twenty-sixth annual meeting, Feb. 27-28. Royal York Hotel, Toronto, Canada.

American Road Builders' Association; Chas. Upham, Engineer-Director, National Press Building, Washington, D. C. Annual convention and road show, Jan. 16-20. Statler and Fort Shelby Hotels, and Detroit Municipal Airport.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City. Eightieth annual meeting, Jan. 18-21, New York City. Annual convention, June 26-July 1, Chicago, Ill.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa. Annual meeting, June 26-30, Stevens Hotel, Chicago, Ill.

Associated General Contractors of America; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C. Fourteenth annual convention, Jan. 16-18. Statler Hotel, Washington, D. C.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis. Third annual convention, Feb. 23. Palmer House, Chicago, Ill.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 333 North Michigan Ave., Chicago.

Engineering Institute of Canada; 2050 Mansfield St., Montreal, Quebec.

Highway Research Board; Roy W. Crum, Director, 2101 Constitution Ave., Washington, D. C.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 1735 14th Street, N. W., Washington, D. C. Sixteenth annual convention, Jan. 16-18. Book-Cadillac Hotel, Detroit, Mich.

National Engineering Inspection Association; B. H. Witherspoon, Secretary, P. O. Box 1115, Pittsburgh, Pa.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C. Third annual convention, Jan. 18. Book-Cadillac Hotel, Detroit, Mich.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C. Seventeenth annual convention, Jan. 17-18. Book-Cadillac Hotel, Detroit, Mich.

National Slag Association; H. J. Love, Secretary-Treasurer, 1449 Leader Bldg., Cleveland, Ohio.

National Terrazzo and Mosaic Association; U. F. Durner, Secretary, 815 West St. Paul Ave., Milwaukee, Wis.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary; Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

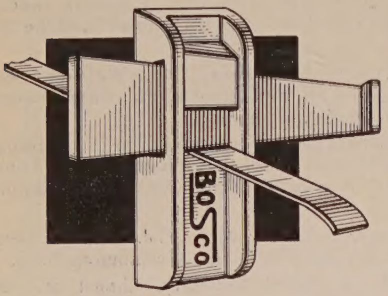
Wire Reinforcement Institute; R. D. Bradbury, Director, National Press Bldg., Washington, D. C.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wis.

New Equipment and Materials

New Band Iron Clamp Designed by Bosco

The Bosco improved band iron clamp is being introduced as a simple and quick means of tying wall forms. The self-contained wedge clamp is set and released with a blow of the hammer.



The wedge slot allows the easy insertion of 14-gauge, ½- or ⅝-in. band iron.

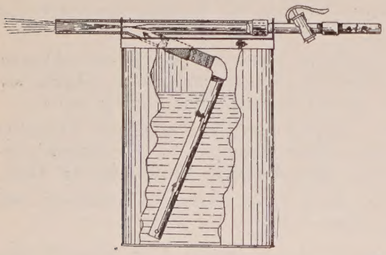
Bosco improved form clamps are designed for use on all form framing, sectional forms, plywood panel forms and fireproofed steel beam soffit forms.

Square nails are eliminated, clamping is secure, and the device can be reused or stored, according to Geo. B. Bosco, Chicago, designer of the clamp.

Spray Control Principle Is Feature of Eureka Outfit

An air pressure concrete spray featuring adjustability and spraying anything from oil paint to fine concrete is being marketed by the Eureka Art Stone Works, Eureka, Calif.

The spray may be fixed at any desired intensity, even while in operation.



Coverage is placed at 1500 sq. ft. per hour.

Flow of the spraying liquid is said to remain constant; the suction and the free discharge being uninterrupted due to the design of the control adjustment. The latter comprises a movable sleeve which covers or uncovers a number of perforations in the upper part of the suction pipe.

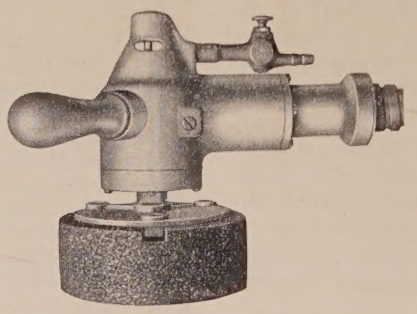
Construction is cast bronze composition.

New Berg Surfacer Designed for Wet-Rubbing

Hand rubbing and wetting of surfaces with a brush is done away with by a water feed concrete surfacer which is now available for wet-rubbing.

Features, said to be exclusive, incorporated in its design are a water control valve at the thumb of the operator, and the water outlet in the center of the carbodisc. Water can not enter the gear housing, according to the Concrete Surfacing Machinery Co., Cincinnati.

The new surfacer may be furnished as a complete machine—consisting of the Berg water feed head and any one of the Berg motor units—or, the water feed head may be purchased as an attachment for Berg concrete surfacers now in use.



Master Builders Company Develops New Type of Mortar Color

Colored Omicron waterproofing, a new type of mortar color combining waterproofing, strengthening and plasticizing as well as coloring qualities, has been developed by the Master Builders Co. of Cleveland, Ohio.

Master Builders Co. states that this is a radical improvement over the usual types of mortar color, as the product adds permanent strength and water absorption protection to the mortar at the same time the mix is colored at no increase in cost. It is also claimed that extensive laboratory and practical tests show that the material makes lower water ratios practical, and that special ingredients check efflorescence, resulting in non-fading color.

Colored Omicron waterproofing is offered in ten colors ranging from light buff to double strength black. The material is in liquid form, a new feature in mortar color, which eliminates weighing and possibility of damage to construction through bags of powdered color breaking.

It is particularly adapted to residential, office building, apartment house, school, church, and public building construction, but also has application to general commercial and industrial buildings.

Stocks of the material will be carried by selected building supply houses throughout the country, as well as by the branch offices of the company.

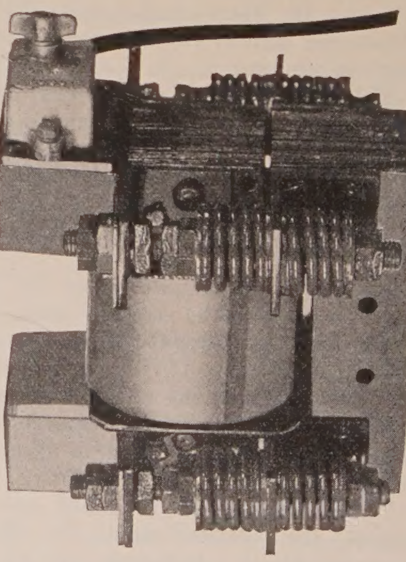
New Syntron Tool Designed for Internal Vibration

A horseshoe magnet and an armature comprise the new, simple Syntron vibrator, for internal compaction of concrete.

This vibrator may be fitted with a handle and a vibrating spud for vibrating floor, flat slab placements or reinforcing bars in concrete products. Another attachment is a vise clamp for clamping the vibrator to the stud or waler of concrete forms, while a third device is a chain clamp for clamping the vibrator to a round column or a round sewer pipe mold. The largest model, V-120, may be fitted with a puddling board for vibrating mass placement of concrete.

It is a product of the Syntron Co., Pittsburgh, Pa.

The gap between the magnet and the armature, held open by springs, is closed 3600 times a minute on 60-cycle alternating current. Moving of the heavy mass of the armature at this speed sets up a powerful vibration that may be applied in a direct line toward any given mass.



Other features are the variety of sizes for different applications and the freedom from moving parts.